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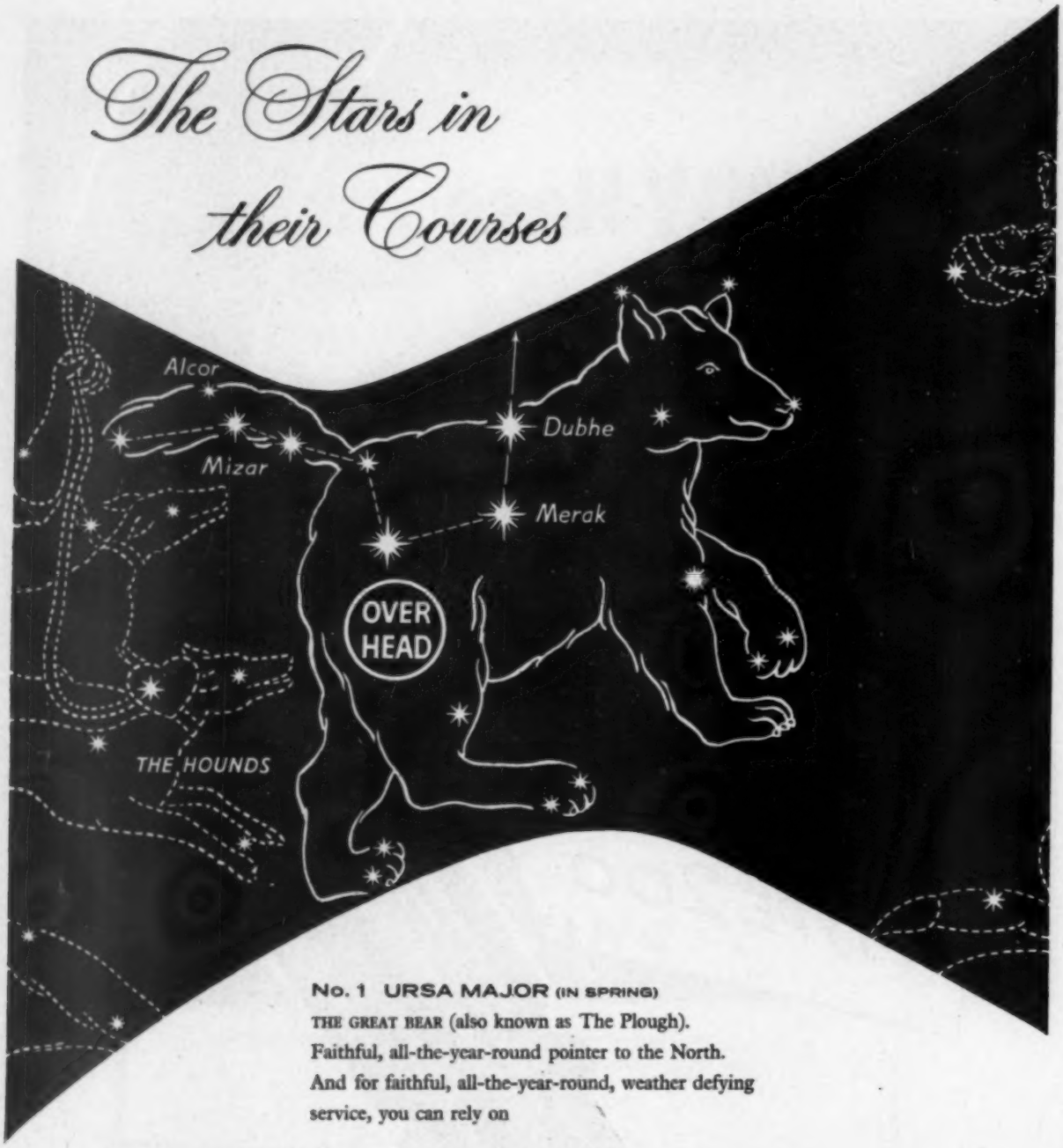

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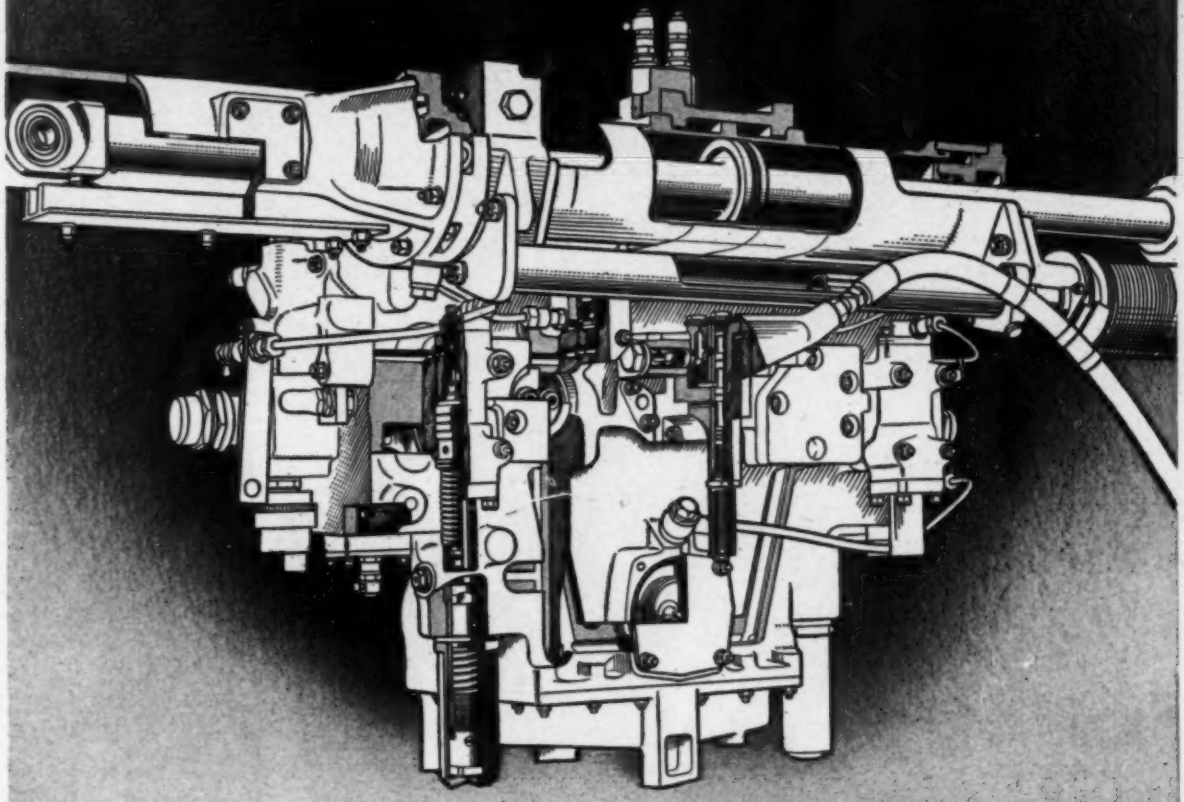

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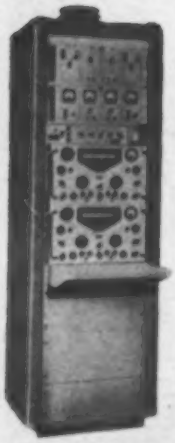

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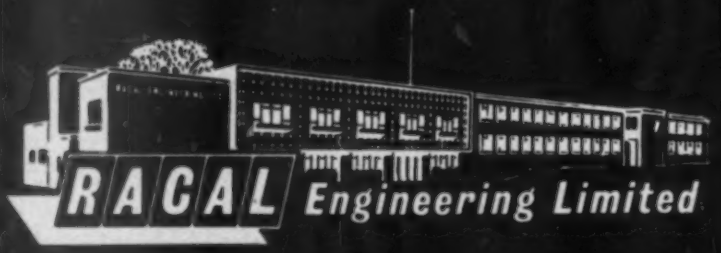

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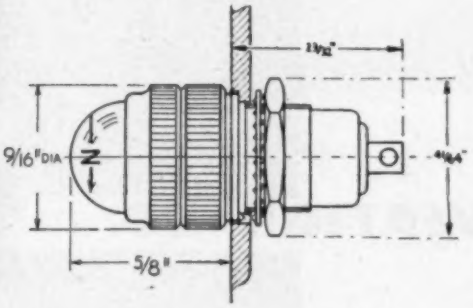
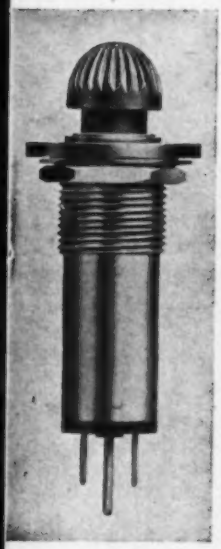


AND THE MINIATURE

PRESS-TO-TEST

FITTING



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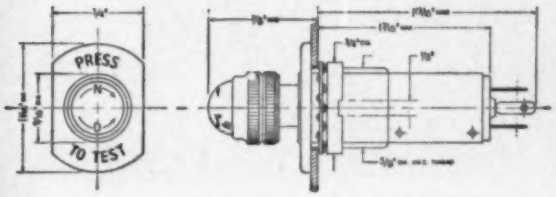

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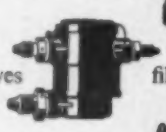
Fuel Tank Pressurisation Systems, designed to meet various operational requirements such as nitrogen blanketing and tank pressurisation, include servo and non-servo systems using servo control valves pressure reducing valves  filter/restrictor valves air or air/nitrogen control valves servo and direct acting vent valves.

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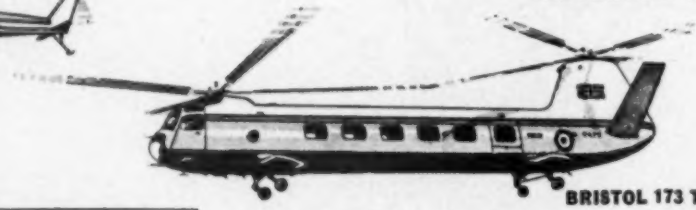

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In announcing that the famous 617 Squadron—the Dam Busters—is to be reformed and equipped with the Avro Vulcan Delta Bomber, believed to be the fastest bomber in service anywhere, Mr. Charles Ian Orr-Ewing, Under Secretary for Air, has said that in the Vulcan "we now have a bomber aircraft which is equal to, if not better than, anything else in the world".

"The Vulcan comes from a good stable"

In addition to Mr. Orr-Ewing's tribute, the Air Officer Commanding No. 1 Group, Bomber Command, had this to say: "We are extremely pleased with the Vulcan, both from the operating and the maintenance aspects. The way in which this large aircraft and its complex system has been brought into use in the front line of Bomber Command, without any of the enforced groundings so frequently experienced with new types of aircraft, is most gratifying. The Vulcan is giving us splendid utilization; indeed, it is far better than we experienced with any other type of aircraft, large or small. The Vulcan comes from a good stable and is liked by the servicing crews as well as the flying crews."

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

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By Thermal, Hill and Wave

CUTTING through the gloomy fog of British sporting flying like a shaft of sunlight is the vigorous progress of this country's gliding movement. In popularity, flying activity and standard of performance, continued and well-defined advances were reported by Mr. Philip Wills in his annual report, last Saturday, as chairman of the British Gliding Association. Active membership of the clubs totalled 3,000 pilots; hours flown during 1957 increased by no less than 38 per cent to over 20,000; and eleven United Kingdom and British national records were broken.

This steady increase in activity is not the only sign of the health of the movement. New ideas are continually being tried, and new problems—which in many cases are corollaries to increasingly high standards—are being tackled firmly. Intelligent and constructive discussion of ways to overcome these problems was a notable feature of the B.G.A. instructors' conference which preceded the annual general meeting.

One problem tied to the increasingly high standards of pilotage and of aircraft performance was mentioned by Mr. Wills in his report. "The natural difficulties of the Channel barrier are getting less and less," he said, "and the best possibilities of breaking our present distance records and achieving distance flights of international standard lie in flights across the Channel and into Europe. But although by our skill and techniques the difficulties imposed by Nature are being overcome, those imposed by man are indeed formidable. . . . The trouble is that a cross-channel day cannot be foreseen in time to make it possible to conform with the existing Customs and other procedures. . . . Additional problems for us are associated with international requirements for airworthiness and air navigation." Clearly the Channel should not be a major obstacle to high-performance flights—provided that ill-judged attempts in marginal weather are effectively discouraged.

Prospects for Poland

Britain's team for the 1958 World Gliding Championships to be held at Leszno, near Poznan, in June, also has its problems. The first is simply to raise enough money to equip the team and send it 850 miles, by sea and road, to Leszno. Once again the Society of British Aircraft Constructors has contributed generously with a gift of £1,000; and once again the Standard Motor Company is lending Vanguard estate cars, the Pye company is providing its lightweight and efficient radio equipment, and the oxygen companies are co-operating wholeheartedly. The Gliding Ball at Londonderry House on Friday last was a sparkling occasion and also, we hope, successful in its aim of raising more money for the Championships Fund.

This sort of effort no doubt causes many a smile in those countries where gliding, as well as powered sporting flying, is completely subsidized by the government. There were a number of wondrous, all-metal glamour-sailplanes from these countries competing at St. Yan in 1956—the contest at which Fred Slingsby's T-42 *boîte à sardines*, at about one-eighth the cost, won the two-seater class—and there will doubtless be many more exotic sophisticates at Leszno.

Here in this country, the final selection of aircraft to be flown by the British team has not yet been made. From the famous Slingsby stable an improved-wing Skylark 3 is emerging, while the Skylark 2 already fits very well into the standard category. Elliotts of Newbury, having developed the Olympia 4 through successive improvements since 1954, are producing the definitive version, the 419, for the open category, and the 15-metre 415 for the standard class.

Aircraft for aircraft, the British types will probably compare well in handling qualities, well in medium-weather performance, and not so well in absolute performance in exceptionally strong soaring weather, with their more refined and expensive foreign competitors. Pilot for pilot, national differences are less clearly marked. Certainly the Navy/Army/civilian combination of the formidable Goodhart brothers, the resolute Colonel Deane-Drummond and veteran birdman Philip Wills is the strongest team ever produced by Britain.

FROM ALL QUARTERS

Satellite Score, 2-2

THE much publicised Vanguard satellite project of the U.S. Navy got under way last Monday, March 17, with the launching into orbit from Cape Canaveral of a small test sphere. One of the most interesting features of this second U.S. satellite, 6¼in in diameter and weighing 3¼ lb, is that one of its two radio transmitters is powered by solar batteries.

Initial reports stated that the new satellite, travelling at 18,000-19,000 m.p.h., was orbiting between heights of 400-2,500 miles—higher than any of the previously launched satellites—and was taking the correspondingly longer time of 135 min per revolution. Also in orbit near the sphere was the final third stage of the launching rocket. Dr. John P. Hagen, director of the Vanguard project, estimated that the satellite would remain in orbit for five to ten years.

A Week of Rocketry

IT was announced last Monday that a number of Skylark upper-atmosphere research vehicles for the International Geophysical Year are to be fired at the guided-weapons range at Aberporth, Cardiganshire, later this year. Skylark, described in our issue of December 6 last, has already been successfully fired on numerous occasions at the W.R.E., Woomera.

Regarding military ballistic weapons, the Soviet Union announced on March 15 her willingness to place Russian long-range ballistic missiles under United Nations control, provided that "the West, and particularly America," gave up military bases from which attacks could be launched upon the Soviet Union. It was also suggested that outer space should not be used for military purposes. The State Department in Washington, commenting upon these suggestions, said that the abandonment of the global network of bases of the U.S.A.F. Strategic Air Command would be "wholly unacceptable."

Space Age Conference

A CONFERENCE entitled *Britain Enters the Space Age* and open to young men and women aged 16-23 is being held in the morning of April 14 at the Royal Festival Hall, London. It has been organized by the Air League of the British Empire and will be opened by the Duke of Edinburgh, who is president of the League, with the Chief of the Air Staff, Marshal of the R.A.F. Sir Dermot Boyle, in the chair.

There are to be four speakers—Prof. W. H. McCrea, of Royal Holloway College, who will discuss the nature of outer space and the challenge it represents; Mr. J. E. Pateman, senior technical executive (guided flight) of Elliott Brothers (London), Ltd., describing control systems and navigation; Mr. A. C. Clarke, formerly president of the British Interplanetary Society and well known for his lectures on space travel; and Mr. D. G. King-Hely of the R.A.E. These four speakers and Prof. H. S. W. Massey of the Royal Society will then form a "brains trust," with Sir Arnold Hall as chairman, to answer questions on space travel.

There will also be exhibits (including a model of the U.S. Explorer) at the conference, tickets for which—at 7s 6d, or 5s to members of the League—must be booked in advance. Applications should be sent to the Air League of the British Empire, Londonderry House, 19 Park Lane, London, W.1.

GROUND INSPECTION: The Duke of Edinburgh being shown round a CF-100 by A.V-M. H. B. Godwin, A.O.C. of No. 1 Air Division, when he visited No. 4 Fighter Wing of the R.C.A.F. at Baden-Soellingen, Germany, on March 12. The Duke was briefed on the division's rôle in NATO and its "Operation Zulu" round-the-clock standby, and saw four Canadair Orenda-Sabres take off on a practice scramble.

Col. Mervyn O'Gorman

WE regret to record that Lt-Col. Mervyn O'Gorman, C.B., a pioneer of aeronautics and motoring, died last Sunday at the age of 86.

He became superintendent of H.M. Balloon Factory at Farnborough in 1909 and in 1911 of its successor, the Army Aircraft Factory, holding that post until 1916, when he was made consulting engineer to the Director-General of Military Aeronautics at the War Office. In his seven years at Farnborough he "rendered eminent public service in the design and construction of aircraft" (to quote from an official history). He was a member of the committee under the chairmanship of Col. J. E. B. Seely which in 1912 outlined a scheme for civil and military aviation which led to the constitution of the R.F.C.

Mervyn O'Gorman was appointed C.B. in 1913 and in 1916 became a lieutenant-colonel in the R.F.C. At one time during the inter-war years (when his work was mainly concerned with motoring) he was a member of more than 30 committees, his aviation appointments including the R.Ae.C. vice-chairmanship, chairmanship of the accidents investigation and civil air transport committee of the Air Ministry and an F.A.I. vice-presidency.

Exploring Airliner Markets

TWO British aircraft company directors have recently departed for Australia, whose leading airlines are all in the market for new equipment. One is Mr. A. F. Burke, managing director of the de Havilland Aircraft Company (and chairman of D.H. Engines), the other is Sir George Edwards, managing director of Vickers-Armstrongs (Aircraft), Ltd. The primary potential customers of the companies which these executives represent are T.A.A., T.E.A.L., Ansett-A.N.A. and Qantas.

Trans-Australia Airlines have definitely decided to buy more Viscounts, of the 810 variety, and are at present seeking government approval for the import of these aircraft. Their choice of medium-haul equipment, formulated by the Adelaide - Perth route, is not quite clear, but strong and persistent reports during the past few months have suggested that the Caravelle is high on T.A.A.'s list. T.A.A., however, might still be regarded as potential purchasers of Comet 4s or Vanguards.

COMING ALONG NICELY: The first production batch of Thruxton Jackaroos seen at their home airfield. Jackaroo Aircraft, Ltd., offer these ingenious Tiger Moth conversions as "the cheapest four-seat aircraft in the world" at a basic price of £1,095 each.

***ON TOP OF ITS JOB:** The new Auster Workmaster (see news-item below) is a fine agricultural and utility machine.*

Tasman Empire Airways, who denied reports a few months ago that they had decided to buy Convair 880s, are known to be strongly in favour of jets. A report from New Zealand indicates their requirement for four Comet 4s (two of which would be modified to meet the freighting requirements of the R.N.Z.A.F.), for operation on the Tasman Sea service between the Dominions, who have equal shares in T.E.A.L.; but now this partnership is being reviewed, and it remains to be seen whether T.E.A.L., as expected, will become predominantly New Zealand-owned. In this event the Comet 4 would be a strong candidate for T.E.A.L.'s patronage.

Ansett-A.N.A. (who are at the moment trying to obtain control of Butler), have already expressed their medium-haul requirement; they want four Lockheed Electras. But it is quite possible, in view of the dollar expenditure required, that the Australian Government may not approve this purchase. In such circumstances Ansett-A.N.A. might well be in the market for Vanguards, particularly as they have also stated their requirement for Vickers Viscount 810s from the same stable.

Lastly, Qantas may be in the market for VC.10s, though they are reported to be seeking approval for the purchase of a further batch of Boeing 707s (presumably 320s). But Qantas are also looking for a medium-range aeroplane, and indeed they are reported to want five Electras (*Flight*, February 14). Here again, the Vanguard cannot be discounted from Qantas' plans.

Nuclear Reverberations

AN unarmed nuclear weapon which fell from a U.S.A.F. B-47 on March 11 virtually destroyed a house and caused a crater 50ft wide and 35ft deep at Florence, South Carolina, and on this side of the Atlantic set off renewed demands in Parliament that American aircraft should not carry these weapons while on training flights over Britain. The Prime Minister was to make a statement on the matter in the House of Commons last Tuesday.

The B-47 concerned in the accident was on a routine flight from Hunter A.F.B., Georgia. Five persons, three of them children, were injured and taken to hospital. A decontamination squad was sent to the scene but it was later announced by S.A.C. headquarters in Nebraska that there was no danger of an atomic explosion or radiation, though it was officially admitted that a small amount of radio-active material had been discharged.

This was the first time a nuclear device had fallen on American soil. The S.A.C. indicate that malfunctioning of the bomb-lock system probably caused an accidental jettisoning. The damage was caused by the detonation of the large H.E. charge which forms an essential part of such a device.

Workmaster Means Business

FURTHER details of the Auster Workmaster, released late last week, suggest that it may well become a winner in the agricultural and utility field. Dimensions are: span, 36ft; length, 23ft 7in; height, 6ft 2in; undercarriage track, 6ft 2in. As recorded in these columns last week, the Lycoming O-360-A engine of 180 h.p., for which the basic Auster airframe already had the necessary strength reserves, will provide ample power for manœuvring, for a 180-yd take-off fully loaded and equipped, and for cruising at 88 m.p.h. between strip and spraying area. Cross-over exhausts and a constant-speed propeller improve the propulsive efficiency; fuel tanks holding 32 gal are located in the wing for safety, the main spray tank being beside the pilot and surrounded by a restrainer cable.

A passenger may be carried behind the pilot, this being a necessity for support operations in many areas. Despite the tank, all-round visibility has been preserved. Large tyres, a strengthened tailwheel spring, a pneumatic tailwheel and hydraulic brakes with separate header tanks for each wheel facilitate ground handling even on soft surfaces. Stronger wing-struts have been fitted, and the Workmaster is being certificated (full normal category) at 2,550 lb. Rate of climb is 650ft/min with full load (950 lb including pilot) and rises to well over 1,000ft/min at light load. Similarly, take-off fully equipped and loaded is 180 yd, but has been measured at around 50 yd empty.

For additional safety a strong seat and 25g shoulder-harness in corrosion-resistant Terylene are fitted, and for comfort the seat is well padded and some soundproofing is incorporated. The windscreen is of double-thickness plastic to resist bird strikes; both carburetter and ventilator intakes have locust screens. In addition, both cold- and hot-air carburetter intakes have filters and a third intake opens automatically if these become choked. Power and pitch levers are paired so that full power and fine pitch may be selected with a single movement.

The boot-shaped spray tank may be quickly removed through a detachable roof panel, and packages with a cross-section measuring up to 33in × 28in loaded instead. Dusting, instead of spraying, equipment may later be provided.

The main competitors of the Workmaster are machines like the Tiger Moth and the Piper PA-18-A; and it has a greater work capacity than either of these. Workmaster price, complete with tank and Britten-Norman spray gear, will be just under £5,000, with delivery offered in about 16 weeks. Crop Culture, Ltd., gave Auster Aircraft the specification for the Workmaster at the end of last year. The first drawing was released to the shops on January 1 and the first flight followed 53 days later, on February 22 (target date was February 21). The first aircraft should be delivered to Crop Culture, Ltd.. this month.

Domestic Competition for B.E.A.?

THE British independent airline Eagle Airways—whose associated company is soon to challenge B.O.A.C. on the Bermuda-to-New York run—have applied for permission to serve the London - Manchester route in competition with B.E.A.

This run, like all other main air routes in the United Kingdom, is the monopoly of B.E.A., and Eagle's intention to challenge the Corporation raises an interesting political precedent. This will be considered in the usual way by the Air Transport Advisory Council. It will almost certainly be opposed by B.E.A., which would in theory mean that the A.T.A.C. would not recommend the Government to accept the application.

But it is likely that Eagle will present a strong case for an increase in service between the country's two main cities: Mancunians have been complaining more and more vociferously about the lack of seats and convenient schedules offered by B.E.A. This may well be a route where independent competition would not materially divert traffic from B.E.A., who have presumably considered it uneconomic to increase their London - Manchester services.

Eagle would operate Viscount 800s as well as Vikings on the route, at an initial frequency of one return service a day, rising to five a day according to demand. B.E.A.'s existing frequency is five return services a day—three by Viscount, two by DC-3.

Boulton Paul Board Appointment

FROM Boulton Paul Aircraft, Ltd., comes news that Mr. G. C. Haynes, A.C.A., director and secretary, has been appointed deputy managing director. Mr. G. A. Woolsey, A.C.A., previously chief accountant, succeeds him as secretary.

***NA.39 PROGRESS** was inspected by the Minister of Supply, Mr. Aubrey Jones, during a visit to the Blackburn and General Aircraft factory at Brough last week. On disembarking from the Ministerial Devon he was greeted by Mr. Eric Turner (left), managing director. M.o.S. officials accompanying the Minister were Mr. F. J. Doggett (Under-Secretary, Air B), Mr. I. S. Jehu (Chief Information Officer) and Mr. W. T. Horsley (Principal Private Secretary).*

UNGUIDED AND GUIDED: The 37-tube rocket pack, described in a news-item on this page, seen fitted next to a D.H. Propellers Firestreak on a Gloster Javelin FAW.7.

English Electric Year

IN his address at last week's annual general meeting of the English Electric Co., Ltd., Sir George H. Nelson included in his review of the year's activities a résumé of the work of the aircraft, guided weapons and aircraft equipment divisions.

In a reference to the P.1B he said that it had been flying at speeds in the region of the world's air-speed record of 1,207 m.p.h., and added that the two new wind tunnels due for commissioning at Warton this year would simulate flight conditions at speeds of up to Mach 4 and Mach 6.

Of missiles—and of Thunderbird in particular, "the only weapon of this category to be ordered for both the Army and the R.A.F."—Sir George said that the relaxation of security had permitted the commencement of an overseas sales campaign, which was being vigorously pursued.

Speaking of the equipment division, he went on to say that they had pioneered the introduction in this country of a system of constant frequency alternating current generating equipment for aircraft, and important production contracts had been received for its installation in V-bombers. Equipment for the power-generating system of the P.1B, now in production for the R.A.F., had also been developed and was being installed.

FROM ALL QUARTERS . . .

Javelin FAW.7 Armament

STREAMLINED packs carrying 37 2-in unguided rockets behind a frangible plastic nose-cone have now been added to the armoury of the Javelin FAW.7, as shown in the photograph above. It is presumed that these packs are to become a standard store for R.A.F. aircraft. In addition, the FAW.7 carries two Firestreaks on the outboard pylons and two Aden cannon in the wings. The extra port visible in the starboard wing just outboard of the outer pylon serves the battle camera. The rocket packs are made by Microcell, Ltd., in glass fibre.

Other Javelin FAW.7 features include increased tankage in the wings, vortex generators near the leading edges, blunt aileron trailing-edges, stall-warning indicators and duplicated q-feel systems, together with more powerful Armstrong Siddeley Sapphires and a later fire-control radar. Afterburning will later be applied.

B.G.A. Awards

ANNUAL awards of the British Gliding Association for 1957, presented by the wife of the Polish Chargé d'Affaires at the B.G.A. Ball at Londonderry House on March 14, were as listed below. In the absence of Col. Deane-Drummond, who is stationed in Malaya, his awards were received by his wife; while Mrs. Ann Welch deputized for Sgt. John Williamson.

de Havilland Cup (gain of height): J. S. Williamson, Army G.C., 26,500ft in a Weihe on July 19.

Manio Cup (goal flight): A. J. Deane-Drummond, Army G.C., 217 miles from Lasham to Land's End on April 6 in a Skylark 3.

Wakefield Trophy (distance): P. A. Wills. Dog-leg flight of 270 miles, Lasham-Firle Beacon-Tarrant Rushton-St. Kew's Highway, in a Skylark 3 on June 23. Commendation to J. Hulme, Cambridge U.G.C., for 268 miles (U.K. record) in a Skylark 2 on May 27.

Volk Cup (out-and-return): A. J. Deane-Drummond, Army G.C., 197½ miles from Lasham to Kidderminster and return in a Skylark 3 on June 1.

Seager Cup (two-seaters): D. B. James and D. Marshall, Surrey G.C. Average speed of 35 m.p.h. over 100 km triangle in a Gull 2 on May 31.

California in England Cup (women's distance): Mrs. A. J. Deane-Drummond, Army and Surrey G.C., 156 miles from Lasham to Liskeard in a Skylark 3 on June 23.

Douglas Trophy (three-flight club cross-country distance): London Gliding Club, 571 miles. C. W. Bentson, 189 miles (Olympia); M. P. Garrod, 190 miles (Skylark 2); and D. A. Smith, 192 miles (Sky).

APPOINTED assistant chief designer of Bristol Aircraft, Ltd., as from March 3, Mr. M. G. Wilde (left) has been the company's chief aerodynamicist since July 1955 and is succeeded in that position by Mr. H. A. Goldsmith (right). In his new position Mr. Wilde, who joined the aerodynamics department of Bristol Aircraft in 1944, will be responsible for organizing preliminary design work on new projects.

Fewer Aircraft for M.o.S.?

FOLLOWING questions by Sir Frank Tribe, the Comptroller and Auditor-General, on the number of aircraft used by the Ministry of Supply for research and development flying and other duties, the total of these machines was reduced last year from 637 to 604—including 138 on loan, 420 allotted to research and development, and 18 for communications. The value of the 604 aircraft (as assessed in October last year) was £50m. Annual running costs, including fuel, spares and maintenance, were £5m.

Sir Frank says (in his report, published recently, on the appropriation accounts) that the Ministry had told him it might be possible to manage with fewer aircraft.

Mechanical Handling Exhibition

OVER 250 firms are taking part in the 1958 Mechanical Handling Exhibition and Materials Handling Convention which is to be held at Earls Court, London, from May 7 to 17 and which will be the largest display of labour-aiding equipment and methods ever presented. It has been organized by our associated journal *Mechanical Handling*, with the full support of the five principal trade associations, and intending trade visitors may obtain tickets of admission from the exhibition manager, H. A. Collman, *Mechanical Handling*, Dorset House, Stamford Street, London, S.E.1.

WESTERN INFLUENCE is suggested by the external appearance of the Czechoslovak Aero L-200 Morava, now undergoing flight tests. Powered by two 160 h.p. Walter Minor 6-III engines, the smart new five-seater was designed by Ladislav Smrcek, of Zlin and Super Aero 45 fame.

Air Estimates Debated

Eight-hour Discussion of £467m

WHEN the Air Estimates were debated in the House of Commons (sitting as a Committee of Supply) on March 10 the Secretary of State for Air, Mr. George Ward, said that their total for 1958-59 was about £467m—over £20m less than the comparable figure for 1957-58, though the true saving compared with the previous year was in all about £57m. One of the ways in which this was being achieved was by reductions in both Service and civilian staffs, the closing of various headquarters, and reduction of Air Ministry headquarters staff. Organizational economies were being carried out, including the possibility of automatic data processing, and experiments with different types of catering.

Mr. Ward said that this year he intended to speak about manpower first and then to deal with the operational side. Recruitment of officers was on the whole satisfactory; the intake of cadets at Cranwell and Henlow had been helped by the R.A.F. scholarship scheme; numbers and percentages of regular airmen on long-service engagements had been steadily rising, and the entry of apprentices and boys last year was 25 per cent up on that for 1956. But as the R.A.F.'s authorized ceiling of 135,000 regular officers and airmen would not at the present rate be reached until 1965, instead of 1962 as intended, the present annual intake would have to be increased.

A limitation had been introduced on the number of postings, which was a disincentive to recruiting; several improvements had been made to R.A.F. uniform and the kit-bag was to be replaced by a hold-all. Mr. Ward paid tribute to the "tremendous contribution" being made by the A.T.C. and the R.A.F. sections of the C.C.F. towards regular recruiting.

Turning to the operational side of the R.A.F., the Minister said he was sure the V-bomber force would remain highly effective, and he made it clear that a long-range version of the powered bomb was being developed. This year the Mk 7 Javelin and Firestreak weapon would be introduced; later, both the Mk 7 and Mk 8 would be given reheat. The performance of the P.1 would be improved by "electronic computing equipment to tell the automatic pilot the place in which to intercept the bomber"; and Service trials of Bloodhound was to begin shortly at North Coates. Mr. Ward paid tribute to the work of the Middle East and Far East Air Forces; he said Singapore would be the long-term base for the R.A.F. in the Far East; and he referred at the close of his speech to the need for "a strike and reconnaissance aircraft" in overseas theatres and to consultations with the War Office about an eventual successor to the Beverley.

Canberra Replacement

MR. GEOFFREY DE FREITAS (Lab., Lincoln) said that the Opposition's quarrel was not with the R.A.F. but with the Government's policy. Where, he asked, were the transport aircraft to move the strategic reserve? What sign was there of a replacement for the Canberra? Would the NA.39 be anything like this? He also wanted to know more about the Victor, and asked whether there was any justification for Air Ministry to have the same number of Air Rank officers for 203,000 men as it did two years ago for 272,000.

MAJ. H. LEGGE-BOURKE (Con., Isle of Ely) quoted *in extenso* from three articles by J. W. Fozard on *The Supersonic Fighter* which had appeared in *Flight* during December 1954, in putting forward a case for developing aircraft which could fly non-stop over vast distances such as England to Australia.

MR. GEORGE WIGG (Lab., Dudley) said that there were 29 squadrons of Canberras in the U.K.; three squadrons of B(1)6s and B(1)8s with the 2nd Tactical Air Force, and four squadrons of the B.3 and the P.R.7. The Americans had 1,600 B-47s; and 260 V-bombers had been ordered and 160 produced—108 Valiants, 77 Victors and 75 Vulcans. He said that maximum production of the Bison and Bear in the Soviet Union was about 300, but he was told they would have about 570 by the middle of 1959 as against 430 U.S.A.F. B-52s. Mr. Wigg said that we were in acute danger in this country of reaching the point where our aircraft industry was "finished."

SIR NORMAN HULBERT (Con., Stockport North) made a comparison of the cost and size of the R.A.F. now and twenty-two years ago. He said that at the latter date the pay of officers and airmen totalled a little over £4m while today it totalled £100m. In those days there were 33,000 men in the R.A.F.; today there were 200,000. Sir Norman said that whatever happened in the future the R.A.F. must have a personnel reserve; and he considered that members of the reserve should get promotion. During forty years the R.A.F. had had its ups and downs. It rose to Olympian heights in war but reached its nadir when Parliament starved it of money, aircraft and men.

MR. P. B. LUCAS (Con., Brentford and Chiswick), commenting that this was "a really critical period" for the R.A.F., said that the Chief of the Air Staff, Sir Dermot Boyle, had had to shoulder a burden not normally borne by one in his position during times of ordinary service; and he believed that Sir Dermot's leadership of the Service had ensured him a place among the great occupants of his office.

Mr. Lucas went on to say that none of the three countries possessing the largest air forces—the U.S.A., Soviet Union, and Communist China—had indicated that it was going to dispose of the manned fighter; and he expressed regret that the R.A.F. did not go for the Folland Gnat to use in its secondary tasks overseas.

Mr. Lucas further asked if it was intended that there should be a successor to the Canberra, and wanted more information on the Blackburn NA.39.

MR. P. WILLIAMS (Con., Sunderland South) said the Strategic Air Command had, he imagined, known its targets for five or perhaps even eight years. He added that the fact that we were dropping the supersonic bomber might well mean that we dropped out of the race for supersonic transport aircraft. He queried whether R.A.F. Transport Command was the most efficient and economic means of providing strategic movement in time of emergency, considering that this task could be performed with greater economy by the civil operators.

VICE-ADMIRAL HUGHES-HALLETT (Con., Croydon East) said that he agreed with members who considered that the Ministry of Supply had outlived its usefulness and was no longer required; it was a mistake to go on interposing a civilian Ministry between a Service Ministry, such as the Air Ministry, and industry.

SIR PETER MACDONALD (Con., I.o.W.), speaking of recruiting, said he did not see any reason why the R.A.F. should not obtain the personnel it required before National Service was terminated. He wanted an assurance that the P.1 would not be cancelled like the SR.177, and suggested that the three Saunders-Roe Princesses should be provided with engines and used by Transport Command for trooping.

MR. FRANK BESWICK (Co-op and Lab., Uxbridge) said that if he were directing "Operation Prospect" he would say three things—that there were more than enough young men ready to volunteer and play their part in the R.A.F.; that the Service was equipped to face conventional attacks and could strike blows sufficiently hard to deter any irresponsible attack; and that these forces would be maintained in efficient readiness until UNO is built into a peace-keeping organization. He asked what the replacement was for the Shackleton, and for the P.1—the latter, if we were going to have it, ought to be in the designer's mind now.

Grounds for Optimism

MR. JOHN BIGGS-DAVISON (Con., Chigwell) said he did not think the terms on which we had accepted the Thor missile were satisfactory. Mr. Malcolm MacMillan (Lab., Western Isles) said that ballistic missiles, compared with bomber aircraft, had a complexity, a vulnerability and a fragility which did not add up necessarily to a good technical argument in their favour; there were all sorts of things which could go wrong. He wanted the Minister also to say something about Civil Defence.

MR. WILLIAM ROSS (Lab., Kilmarnock) said that though improvements in Service conditions were important, he did not think that in the long run they were the real answer to the recruiting problem; it would not be a bad thing for the Secretary of State to pay some unexpected visits to some stations to find out exactly what was happening. He might find there was still room for more cleaning up. Mr. Ross also asked whether it was fair unless the R.A.F. had a promotion system which offered everyone equal chances.

MR. C. I. ORR-EWING, the Under-Secretary of State for Air, replied to the debate, which had lasted for eight hours. On the question of re-engagements (which had been raised by Mr. Ross), he said that under its terms of reference the Grigg Committee was investigating what was necessary to make people who were already in the Services re-engage. Its report was awaited with the greatest interest.

As to recruiting as a whole, Mr. Orr-Ewing thought there were grounds for optimism. The Grigg Committee was examining what measures are needed to stimulate it. On promotions, the Under-Secretary said that senior posts went to the best men, irrespective of their branch.

Speaking of air transport, he said that the right balance between Transport Command and civil aircraft which were available was a matter for strategic and military judgment; but the Service had to have in its hands and immediately available a significant quantity of transport. The "front line" of Transport Command had almost doubled since 1951 and now consisted of 30 Hastings, ten Comets and 24 Beverleys (four of the last-named being at present detached in Aden). The transport capacity of M.E.A.F. had gone up by 50 per cent and that of F.E.A.F. by 150 per cent. since 1951. In sum, we could reckon on about twice as much airlift capacity in ton-miles for military purposes as was available to us seven years ago. In due course a successor would be needed for the Beverley, and consultations were going on with the War Office; when the twenty Britannias—to be operated by Transport Command—came along they would be "extremely useful."

Mr. Orr-Ewing paid tribute to the work of the two helicopter squadrons in the Far East; and on the subject of a possible successor to the Canberra, he said that such an aircraft would need to have "built-in" flexibility. Air Ministry were conscious of the importance of this matter and would reach a decision as soon as possible. Finally, of the Thor missile he said: "We are satisfied that when they are deployed in this country, they will constitute an effective addition to the deterrent power of the West."

HERE AND THERE

Royal Salute

OVER 80 Royal Netherlands Air Force fighters, including 24 Hawker Hunters, will take part in a fly-past over Amsterdam on March 25 when Queen Elizabeth and the Duke of Edinburgh arrive in the royal yacht *Britannia* for a State visit.

No Slow Coach

A LOCKHEED Jetstar has set up an unofficial speed record for transport aircraft by flying 1,926 miles from Edwards A.F.B., California, to Dobbins A.F.B., Georgia, in 3 hr 29 min—an average speed of 553 m.p.h. The Jetstar will be produced at Lockheed's Georgia division.

Dornier Research

PERMISSION has been given to the Dornier aircraft company by the Baden-Wuerttemberg State Government to construct a research and development centre near Immenstaad on Lake Constance. A company spokesman said that besides developing military aircraft Dornier would also work on civil projects and hoped in the future to produce a flying-boat.

Simulated Space-flight

A FIVE-DAY test of endurance in conditions similar to those in a space vehicle flying at 18,000 m.p.h. at 140,000ft was begun last week at Wright-Patterson Air Force Base, Ohio. In a cabin 17ft long, 7ft wide and 6ft high, a five-man crew (captain, co-pilot, engineer, defence director and navigator) worked 12-hour and 16-hour shifts, dealing with flight situations and carrying out psychological tests. The crew's activity was continuously photographed and each man's brain reactions, heart-beat, blood pressure, temperature and muscle tension were recorded.

LINK FOR A CHAIN: Decca Mk 10 transmitter equipment on final test immediately before its despatch to New York, where the latest Navigator chain is under construction.

WEB-FOOTED AMICO: Now on a sales tour in this country, the very attractive and efficient Piaggio P.136 amphibian posed for this picture in the Pool of London last week. Many have been assembled in America by Kearney and Trecker under the name Royal Gull.

Final Circuit

ONE of the world's earliest aviators, Gervasio Videla Dorna, has died in Buenos Aires at the age of 74. He held International Licence No. 8, issued to him in France forty-nine years ago.

Executive Heliport

A HELICOPTER site is to be built at the Leeds works of Dunlop and Rankin, Ltd., constructional engineers, for the convenience of visitors. Flights will be made initially to Yeadon Airport.

Herculean Octet

EIGHT U.S.A.F. C-130s recently made a mass flight across the Pacific from Travis A.F.B. in California to Ashiya, Japan. Setting out from Ardmore, Oklahoma, they made their journey of more than 8,000 miles via Travis and thence to Hickam A.F.B., Hawaii, Kwajalein Island and Guam. In command was Lt-Col. E. L. Hibner of the 772nd Troop Carrier Sqn. This is the U.S.A.F.'s first deployment of turboprop aircraft in Japan.

Blackburn 50th Anniversary

NEXT year Blackburn and General Aircraft celebrate their golden jubilee, for it was in 1909 that the first aircraft built by Mr. Robert Blackburn, the company's founder, flew from the seashore at Marske, near Saltburn. A survey of the fifty years is being prepared and Mr. M. G. K. Byrne, publicity manager (at the company's H.Q. at Brough, E. Yorks), would be glad to receive any relevant information or photographs—in particular a photograph of a pusher-type triplane built in 1915 and the only one of its kind manufactured by the firm.

Institute of Metals Jubilee

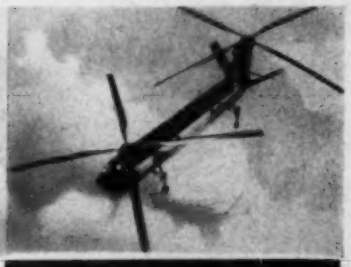
UNDER the presidency of Marshal of the Royal Air Force Lord Tedder, the golden jubilee banquet of the Institute of Metals is to be held at Grosvenor House, London, on May 1. The principal guest will be Lord Hailsham. Tickets, price two guineas, may be obtained from the Secretary of the Institute, 17 Belgrave Square, London, S.W.1.

French Missile Development

THE French Minister of Finance, M. Jacques Chaban-Delmas, announced in Paris recently that an association had been formed by leading French aircraft manufacturers and industrialists, at the suggestion of M. Henri Desbruères, president of SNECMA, to study the manufacture and development of intermediate-range missiles.

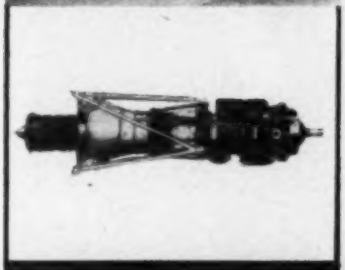
Venice Light Aircraft Show

THE seventh international exhibition of light aircraft, gliders and helicopters of new design will be held at the San Nicolò di Lido airport at Venice from July 16 to 20. The last show, held in 1956, produced a lively concourse of Italian, French, German, Jugoslav, American and Czechoslovak machines. The organizers offer free hospitality at a luxury hotel to pilots and crews and free refuelling for new aircraft participating. Applications should be made to VII Mostra Internazionale Aeronautica, San Marco, 1413/A, Cà Giustinian, Venice.



GAZELLE FREE TURBINE

Chosen for the Bristol 192 and the Westland Wessex helicopters.



ELAND TURBO PROP

Chosen for the Fairey Rotodyne, world's first vertical take-off airliner, and the Westland Westminster.

TIP THRUST UNITS

The boosters that are fitted to the Saunders Roe Skeeter.

NAPIER

POWER FOR THE WORLD'S HELICOPTERS

There are 3 Napier power units specifically designed and developed for helicopters. All are inherently safe to operate, simple to control and economical to maintain.

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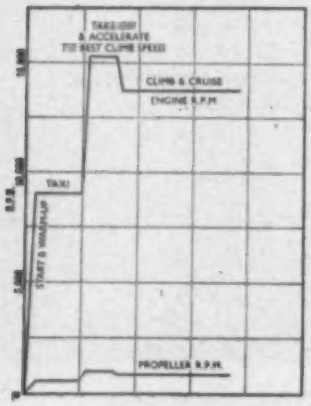
A Member of The **ENGLISH ELECTRIC** *Aviation Group*

CRC 8.38

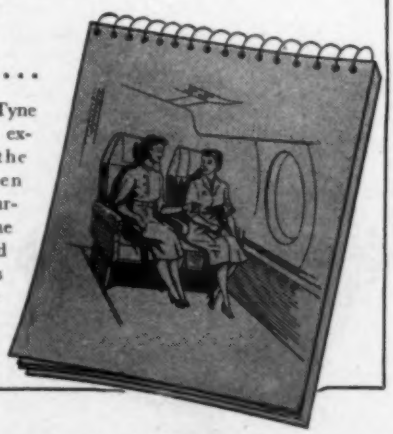
Yes, with the **VANGUARD**

The many problems of noise nuisance on and around airfields will be reduced by the introduction of the Vickers Vanguard. Noise from the four Rolls-Royce Tyne propeller-turbines is remarkably low for an aircraft of the Vanguard's size and power. This will be of particular advantage when operating from airfields in or near residential areas. A lower noise level on the airport will also increase efficiency in the administrative blocks and improve the broadcasting of passenger information. The lower interior noise and vibration will win approval from operators, pilots and passengers.



For your notebook...

Gases from the Tyne engines are only exhausted after the power has been absorbed by the turbine. This is one reason for reduced noise. The other is the low propeller tip speed.



VICKERS VANGUARD

FOUR ROLLS-ROYCE TYNE PROPELLER-TURBINE ENGINES

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

TGA AT541

Eight days after its eight-month refit, the Handley Page Dart Herald is seen making its first flight at Woodley, Reading, on March 11. S/L. H. G. Hazelden, Handley Page's chief test pilot, was at the controls. The engines of this converted prototype Herald are Rolls-Royce Dart 527s of 2,100 e.h.p., driving the biggest Rotol propellers yet chosen for the Dart—12ft 6in in diameter. H.P.'s Dart Herald programme, as laid down a year ago, is on schedule. Certification is due in the autumn.

CIVIL AVIATION

THE QUEEN MOTHER'S MAL VOYAGE

NO one in the air transport industry could have felt anything but sympathy for the misfortunes which beset Australia's international airline last week. To Qantas, appropriately, came the honour and responsibility of bringing Queen Elizabeth the Queen Mother home to England following her five-week 25,000-mile tour of Australia and New Zealand. But three separate—and, so far as can be judged, unrelated—technical failures *en route* accumulated in a four-day delay. Though doggedly refusing to desert her Australian crew in favour of a B.O.A.C. Britannia which was flown out specially to Entebbe after the second failure, Her Majesty did finally transfer aircraft at Malta. Here a hydraulic fault had occurred; the day before, at Entebbe, ignition trouble had caused an 18 hr delay—trouble in the engine which had already replaced the No. 3 Wright Turbo-Compound that had failed over the Indian Ocean *en route* from the Cocos Islands on March 7. This was apparently due to a cylinder-head failure, causing damage to the cowling. It resulted in a diversion to Mauritius and, as we reported last week, the Queen Mother was unable to open Nairobi's new airport at Embakasi on March 8.

Such a chapter of mishaps is indeed rare in Qantas' experience, and the Australian airline was most distressed that it should have happened on this important flight. No doubt there was no surer way of getting the royal passenger home than in a B.O.A.C. Britannia; but there were many who felt that Qantas could have undertaken their own rescue-operation with another Super Constellation which was standing by at London Airport.

APPROVAL FOR THE ELAND

THE third British turboprop engine has now been cleared by the Air Registration Board for public transport operations. Last week the Napier Eland NEl.6, rated at 3,500 e.h.p., passed its 150-hour type test under A.R.B. and C.A.A. conditions. A certificate of approval has been issued by the A.R.B., and the Board have sent a copy for endorsement by the C.A.A.

As a result, approval of the Eland installation in the Convair 340 and 440 is likely to be a straightforward matter. This will greatly assist Napier's campaign to bring the engine to the notice of those operators of Convairs, DC-6s and Constellations who are interested in converting their piston fleets to turboprop power. (One airline, R.E.A.L. of Brazil, has already decided to convert three of its Convair 340s to Eland power, with the prospect of more conversions to follow.) It will also assist promotion by Convair and Canadair of the Convair 540, the designation of production 440s with Eland engines—as under construction at Canadair for the R.C.A.F.

Military-type approval of the Napier Eland has also been obtained, the engine having passed, at the same rating, a 150-hour military-type test under conditions laid down by the Ministry of Supply.

NOISE MEASUREMENT TECHNIQUES

AS described in *Flight* last week, the Port of New York Authority has given leave for the Comet 4 to use New York International in daylight and under V.F.R. conditions. This permission followed a series of tests which were carried out at Hatfield last November by Bolt Beranek and Newman Inc., of Massachusetts on behalf of the P.N.Y.A. From these tests it was concluded that "the noise of the Comet jet airliner is subjectively comparable to the noise of large present day four-engine propeller-driven airliners." The Caravelle had been subjected to similar tests the previous spring and was consequently accepted for operational use at New York International.

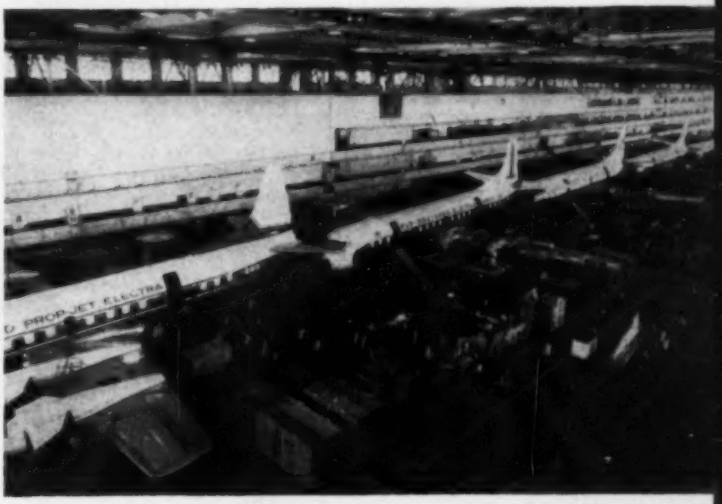
In the Hatfield tests, measurements were taken from four positions situated directly under the flight-path. These points were respectively 2.2, 2.5, 3.0 and 3.5 miles away "from the start of the take-off roll" (i.e., brakes-off). Typical take-off and climb techniques for the Comet (G-ANLO) were as follows: (1) Gross weight 115,000-126,000 lb; unstick point 2,000-2,300ft; 8,000 r.p.m. to altitude of approx. 1,000ft then reduce to 7,100 r.p.m.; climb gradient at 7,100 r.p.m. approx 1 in 8. (2) Gross weight 133,000—142,000 lb; unstick point 3,000-4,000ft; reduce from 8,000 to 7,100 r.p.m. at approx. 800ft to climb at gradient of 1 in 9. For two special low-climb take-offs power was reduced from 8,000 r.p.m. at 500-700ft. Such techniques allow the aircraft to climb to approximately 1,000ft within two miles from the start of the take-off roll "thus resulting in the lowest possible noise exposure for the residential community under or near the take-off flight-path."

Thirteen Comet take-offs were measured by each of two recording groups. A few take-offs were also recorded of a B.O.A.C. DC-7C and a P.A.A. DC-6B to provide comparable data.

In order to utilize the same test positions for taking records of landings it was necessary to perform downwind approaches. In most cases simulated landing approaches were made at a glide angle of 3 per cent. It is acknowledged that this technique, involving high engine power, extended flaps and low altitude, "represents an unusually noisy landing condition."

The report sets out to compare "community response" by measuring the three main characteristics of jet noise: levels, duration and frequency distribution.

The first set of tests suggested that while the low-frequency take-off noise level of the Comet at 2.2 and 2.5 mile positions (i.e. after power reduction to 7,100 r.p.m.) is about ten decibels lower than that of the propeller-driven aircraft, the Comet's high-frequency take-off noise level exceeds that for the piston aircraft by approximately five decibels.



Electra assembly at Burbank shows, left, the third test aeroplane for Lockheed; next is the first airliner for E.A.L., due for delivery in September (note the promotional markings: "Fly-Eastern's Electra Prop-Jet"). Next is the test-machine ordered by Allison; and in the distance are E.A.L.'s next aircraft. Eastern may put their Electras on the New York - Florida run in time for the Christmas traffic-peak, and no doubt Northeast will compete with their Britannia 305s, C.A.A. certification of which is due in May.

CIVIL AVIATION . . .

REPORT ON THE RINGWAY ACCIDENT

IT will be recalled that the cause of the accident to B.E.A.'s Viscount 701 G-ALWE on March 14, 1957, at Ringway Airport, Manchester—the fatigue failure of a bolt in the starboard flap-retaining structure—was quickly established. But only last week came the full report of the public inquiry. Below are summarized the main findings of the Commissioner, Sir David Cairns, Q.C., who was assisted by three assessors.

FROM the point of view of the report the important flap unit [see illustrations below] was starboard flap unit No. 2. The important fitting was the aft lower fitting of that unit and the important bolt the larger bolt through that fitting. This was of $\frac{9}{16}$in diameter and the smaller bolt at the same fitting of $\frac{1}{2}$in.

In the wreckage were found the flap unit and the main part of the aft bottom fitting with the head and part of the shank of the $\frac{9}{16}$in bolt (broken off so as to leave only one thread), while the lug of the fitting was still attached to the trailing-edge member by the $\frac{9}{16}$in bolt. The remainder of the $\frac{9}{16}$in bolt, together with its nut, was never found, despite diligent search. The surface of the break in the $\frac{9}{16}$in bolt showed on examination an appearance which left no doubt . . . that the bolt had been subject to fatigue.

The report summarizes the R.A.E. examination of 845 bolts removed for inspection from 100 Viscounts. Of these 33 showed signs of fatigue, its incidence being greater in bolts from aircraft which had made more landings. (G-ALWE had flown more hours, and made more landings, than any other Viscount but one—6,902 hours and 4,553 landings. Also, it had flown 3,639 hours and made 2,973 landings since "Mod. 799.")

Mod. 799 had been applied to WE in March 1955. According to the original design the larger bolt for the lower fitting of No. 2 flap unit was of $\frac{1}{2}$in diameter. With the earlier Viscounts some trouble was experienced with the flaps. The defects were not of a serious nature. . . . The decision was [made] to increase the diameter of the bolt to $\frac{9}{16}$in.

Of all the Viscounts to which Mod. 799 was applied after delivery to operators, one was modified by Vickers, four by Aer Lingus and 17 (including WE) by Marshall of Cambridge.

Examination of the fitting concerned on WE after the accident revealed certain unusual features, as follows:—

(a) The marks of the bolt heads and nuts (both the original $\frac{1}{2}$in one and the later $\frac{9}{16}$in one) on the fittings were uneven, i.e., were more pronounced at one side than the other, indicating that loading on the bolt would not have been truly axial; the position of the deepest impression of the nut of the $\frac{9}{16}$in bolt corresponded approximately to the fatigue origin on the bolt. . . .

(b) The front face of the fitting had been milled down by about 0.1in, one effect of this being that the lug was 0.1in thinner than as designed.

(c) Because the part of the trailing-edge member of the wing against which the fitting had to rest had three snap rivet heads projecting from it three small depressions had been made in the face of the fitting; but the edge of two of these depressions had fouled their rivet heads.

Mod. 799 . . . was performed on WE by Marshalls. They reamed a $\frac{9}{16}$in hole which may not have been co-axial with the original $\frac{1}{2}$in hole. The reaming of this hole on an assembled wing was an awkward job. [The report then describes the considerable physical awkwardness of this modification.]

Subsequent experiments [continues the report] go to show that when a hole is enlarged in the way described the original hole normally tends to keep the reamer in true alignment. Nevertheless, in the result the axis of the $\frac{9}{16}$in hole was not true. How this came about remains uncertain. At the time when WE was modified Marshalls had already applied Mod. 799 to about ten Viscounts. Before any of this work was done Marshalls' inspectors and the operatives concerned spent some time at Vickers' factory to study the operation; moreover, when the first three or four modifications were done by Marshalls an inspector from Vickers was present. It appears that at the time when this work was done people highly experienced in this type of work would never have supposed that a reamer carefully operated in the manner described would "wander" appreciably.

The machining of the face of the aft fitting was done in Vickers' workshops. There should have been a concession note for this work, but it has not been possible to find one and probably none was issued. The Commissioner had been assured, and accepted the assurance, that the work would not have been done without obtaining the oral consent of the design department and that those responsible for the design had believed, and still believe, that the fitting was still of adequate strength with this amount of metal removed.

When the 0.1in of metal was removed the depressions remaining in the surface of the fitting [to accommodate the rivet heads] would obviously be too small and would have to be enlarged. Again this work should have been covered by a concession note but apparently it was not. However, it was obviously necessary to do it. For some reason which is unexplained, two of the depressions were not exactly in the right position and instead of completely enclosing their rivet heads the edge of each of these two rested on the edge of the rivet head. This meant that the forward face of the fitting was not in close contact with the trailing edge member. . . . Two possible consequences would be:—

(1) That when the two bolts were tightened up the fitting would be under stress which may have caused the lug to break off. . . .

(2) That when the original $\frac{1}{2}$in bolt was removed for Mod. 799, the fitting still held by the $\frac{9}{16}$in bolt would slightly spring away at the other end of its face. . . . This was a possible cause or contributory cause of the faulty seating of that bolt. It must, however, be remembered that the seating of the corresponding bolt on the port wing was also faulty, although the fitting was snugly against the trailing-edge member.

A careful experimental investigation had been made by R.A.E. into the question of whether faulty seating of the bolt head or the nut had any effect on the incidence of fatigue. The findings might be summarized as follows: with loads up to 4 tons/sq in both well-seated and badly seated bolts still had an indefinitely long life; between 4 and 8 tons/sq in, well-seated bolts still had an indefinitely long life but badly seated bolts had a limited life; from 8 to 12 tons/sq in both had a limited life but the life of a well-seated bolt, expressed in alternations of load, was about 50 times that of a badly seated one. Up to the time of these investigations it was not known even to experienced aeronautical engineers that the seating of a bolt could have such an important bearing on fatigue life; the matter had apparently never been studied before except for one series of experiments in the United States, the results of which had been published in 1955 but were not widely known. It was now clear that the mal-alignment of both $\frac{9}{16}$in bolts in WE was an important factor to be considered in relation to the high degree of fatigue which had developed in both of them.

The Report goes on to describe flight-tests and ground-tests made by the R.A.E. and Vickers to establish whether the pilots of G-ALWE (Capt. Thomas R. Breheny and First Officer Douglas Palin) could have averted disaster by corrective use of aileron. The findings were that, in fact, with the starboard No. 2 flap buckled up as it was, the asymmetric control could have been restored by about 4 deg of aileron—well within the maximum aileron movement. It was therefore concluded that as a sequel to the flap failure, the aileron-control ground-locking wire had been pulled, and the pilots found that the ailerons had become locked.

It is necessary to explain how the bolt could have been subjected to oscillatory stresses of such a magnitude as to produce a fatigue failure. No. 2 flap unit was situated to the rear of the rib which carried the main undercarriage leg, and therefore shocks transmitted by the leg on touchdown and subsequent taxying would cause oscillatory stresses in the bolt itself. Furthermore, the unit was in the proximity of the inner engine and therefore any buffeting of the flap from the propeller slipstream, and indeed from the undercarriage leg when in the down position, would cause additional oscillatory stresses on the bolt and fitting. The measured value of these oscillatory stresses was ± 3 tons/sq in, or possibly 20 per cent greater. It was possible that during the life of the bolt there might have been a million such stress repetitions. Reference to a graph which summarized the results of experiments made by R.A.E. with a number of bolts showed that this was perilously near the failing load for bolts whose heads and nuts were not properly seated.

Conclusions and Recommendations

The Commissioner concludes that the accident happened because: (a) the lug broke; (b) the $\frac{9}{16}$in bolt broke because it was badly fatigued; (c) the aileron became locked when the flap unit moved away from the trailing-edge member.

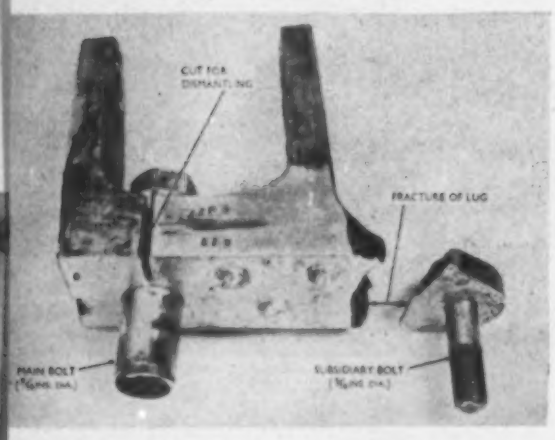
He was satisfied that this was the probable order of events, though it was not certain that the lug broke before the bolt. Even if the lug broke first, there was nothing to show that a major structural failure would have occurred if the bolt had not been severely fatigued.

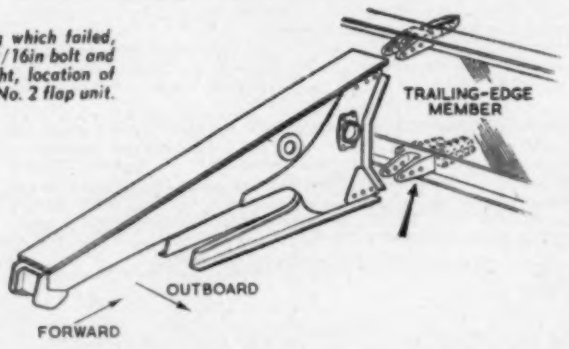
He adds that the accident was not "due to or contributed to by the act or default or negligence of any party or any person in the employ of that party." Finally his report recommends:—

(a) That reliance on a single bolt in tension for the support of a primary structure should be avoided if possible.

(b) That where such bolts are used an ample margin of strength should be allowed (having regard to the material of which the bolt is made) so as to ensure that fatigue will not develop at any time in the life of the bolt.

(c) That where such bolts are used the seating of the bolt and nut should be carefully checked.





Left, the flap fitting which failed, showing the broken 9/16in bolt and the broken lug. Right, location of fitting in relation to No. 2 flap unit.

Fairey Rotodyne coming in—

on Dunlop Tyres, Wheels and Brakes

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We design, manufacture and supply heat exchangers for many purposes in both aluminium alloy and stainless steel. This particular example is for the Vickers Viscount's anti-icing system. Similar units are supplied for the Fokker Friendship and the Bristol Britannia.

This thermal blanket is in refractory fibre cased in .004 inch (.1016 mm) stainless steel. It was made-to-measure and is extremely light, the dimpled construction being responsible for its great strength. Specified for Rolls-Royce and Armstrong Siddeley jet and turbo-prop engines. Approved by the A.R.B.

High pressure fuel-cooled oil cooler for high performance gas turbine engines. This unit is used in the Armstrong Siddeley Sapphire S.A.7.

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We have enormous experience and wide resources. If we can help you in any way with heat control equipment, please contact us. We are always at your service.

We are now introducing Sealed Blankets for Civil Aircraft

Mr. J. B. Veal, C.B.E., A.F.C., A.F.R.Ae.S., appointed to the newly created M.T.C.A. post of Deputy Director-General of Navigational Services (the Director-General is A. Cdre. W. E. G. Mann). Mr. W. E. B. Griffiths takes over Mr. Veal's former post of D.G. of Civil Aviation Safety and Licensing.

CIVIL AVIATION . . .

AIRPORT COST-PLUS

PUBLICATION of the *Civil Appropriation Accounts, 1956-1957* (16s, H.M. Stationery Office), has revealed some depressing details on British airport costs. The total cost (including depreciation, interest on capital and administrative costs incurred other than at airports) to the M.T.C.A. for operating the 26 airports under its control amounted to £8.8m in 1956-57. Total revenue was only £3.4m, leaving a net overall loss of £5.4m.

Sir Frank Tribe, Comptroller and Auditor-General, expresses particular concern at the steadily rising cost of constructing Gatwick airport. The original estimate of £6m as the capital cost of the first development stage (one main runway, the main terminal buildings, the control tower, the new railway station, and cost of land and of road diversions) was prepared in 1952 by the Air Ministry Works Department. After work had been in progress for some months it was announced, in May 1956, that this limit of £6m would be maintained, despite a rise in costs. But by the following October the estimate had increased to £6.6m, by May 1957 to £6.8m, and by December 1957 to £7.2m of which £4m has already been incurred. Sir Frank notes that the M.T.C.A.'s finance branch had difficulty in reconciling actual expenditure with amounts shown on the contracts. Two causes given were "extraordinary measures" taken in order to complete work by Easter 1958, and last-minute changes of plan on the part of the Ministry.

"NO, NO, NO, NO"

A FIRM negative, as quoted above, has—according to reports in *Aviation Daily*—been the reaction of the American Flight Engineers' International Association to suggestions that they should merge with the American Airline Pilots' Association.

The dispute between pilots and flight engineers about crew-complements in the jet age continues to be unresolved, and it is echoing more and more loudly in the U.K. The attitude of the American pilots—and most American airlines—seems to be that the increased simplicity of turbine transports will make it possible to dispense with the flight engineer, with consequent improvements in economy for the airlines, and in salaries for the pilots.

Quite naturally the flight engineers express grave concern, saying that public safety would be in jeopardy if their services were dispensed with. Their case (discussed at length in *Flight* for July 5, 1957) is a strong one.

Certainly a merger with the pilots' association is not likely to result, in the words of the American Federation of Labor, "from both sides sitting down to work out an amicable solution." The engineers have a strong trump card: United States law requires that a flight engineer be carried in all American transport aircraft certificated for more than 60,000 lb gross weight. A flight engineers' strike, if it came to the point, could ground the whole of America's domestic trunk and overseas air transport operations.

In the U.K. the flight engineers seem to have won the argument which threatened the inauguration of B.O.A.C. Britannia services in February 1957. B.O.A.C. are at present returning all their Britannia 312s to Bristol—no doubt at considerable expense—for, among other things, re-arrangement of the flight deck to provide a proper station for the flight engineer. The B.O.A.C. Britannia cockpit layout, as specified, has never been completely satisfactory in this respect.

BREVITIES

WITHIN four hours of a B.O.A.C. Britannia establishing a new New York to London "record" of 9 hr 32 min on a crew-training flight, an El Al Britannia on scheduled service with 52 passengers further reduced the time to 9 hr 22 min.

* * *

An Il-18 has flown from Moscow to Leningrad in 2 hr 10 min on a test flight. Regular services on this route "will start soon."

* * *

B.O.A.C. plan to re-open services to Teheran on April 22. A Britannia proving-flight took place last Friday.

* * *

The Government of Morocco have barred Iberia from operating into Morocco. Iberia's service between Tetuan and Nador will be taken over by Royal Air Maroc.

* * *

Transatlantic airlines are attempting to introduce a 40 per cent rebate on freight consignments weighing over 100 kg and consisting of commodities eligible for specific commodity rates.

* * *

Aeroflot in 1957 achieved its biggest-yet traffic gains: no hard figures are given, but ton-km increased by 25.7 per cent, passenger loads by 67.2 per cent, cargo by 21 per cent. Next year's targets, respectively, are 25.6, 27.6 and 17 per cent.

* * *

The Minister of Transport was asked in the Commons on March 12 about his policy in regard to the fitting of rearward-facing seats in airliners. Mr. Watkinson replied, in effect, that the Air Registration Board had advised him that there is insufficient evidence to make such seats compulsory (see also page 403, and page 249 of *Flight*, February 21 issue).

Aviation Daily reports that Convair are studying the possibility of producing the Convair 540 (Eland 440) in Brazil.

* * *

The new experimental Fido installation is to be put into operation "at an R.A.F. airfield" within the next two months.

* * *

One of Butler Air Transport's Ambassadors was substantially damaged last week when, according to reports from Australia, the wheels retracted while on a test take-off.

* * *

The first order for Caravelles from a private French airline has been placed: Air Algerie will take delivery of three between January and March of 1960. Sud Aviation's order-book now accounts for 34 Caravelles bought by six airlines.

* * *

As this issue of *Flight* goes to press comes news of the appointment of Dr. K. G. Bergin, M.A., M.D., D.P.H., F.R.Ae.S., as Warden of the Court of the Guild of Air Pilots and Air Navigators. He succeeds the late Sir John Boothman. G.A.P.A.N. announces also that the Master Air Pilot Certificate has been awarded to Capt. F. J. Evans of B.E.A.

* * *

Membership of the R.A.F. Reserves Club in London has now been extended to "gentlemen who are engaged in the aircraft or air transport industries." Civil airline crews are offered a special subscription rate of £2 12s 6d per annum. Full details are obtainable from the Secretary, 14 South Street, Park Lane, London, W.1.

(Left) PanAm Stratocruisers can now be seen at London Airport with KC-97-style radar. It is unlikely that B.O.A.C. will consider so equipping their Stratocruisers, soon to be replaced by Britannias.

(Right) Exhibition model of the East German axial turbojet engine 014, four of which are fitted to the BB.152 short-range jet transport (see p. 347, last week). Thrust is reported to be 6,950 lb and the engine is said to be of East German, and not Soviet, design.

OPENING DAY AT EMBAKASI

Scenes at Nairobi's New Airport

TO the 20,000 people who gathered for the opening ceremony at Nairobi's new airport on Sunday, March 9 (briefly reported in our last week's issue), disappointment that the Queen Mother could not be there in person could not overshadow the African gaiety of the occasion. Government officials expressed mild surprise at the enthusiasm of some 15,000 African spectators who packed the tiered stands and thronged the static park—but many had travelled from far up-country and were determined not to miss anything of East Africa's biggest and best air show.

In a garden party atmosphere and in garden party weather, Africans, Asians and Europeans strolled among aircraft that few displays anywhere can ever have rivalled for variety: Cessna 180s and Chipmunks for police and club flying, and a Bonanza, Piper Cubs and Super Cubs, an Apache and a Macchi 320 were a representative selection of Kenya's light aircraft. A Rapide, Heron, East African Airways' DC-3 (Sagana 2, used by the Queen and the Duke of Edinburgh in Uganda in 1954) and Canadair, Hunting Clan Safari Viscount and Air India Super Constellation were a familiar cross-section of air transport aircraft using Nairobi. But it was on the jets—B.O.A.C.'s Comet 2E, a Venom FB.4 from R.A.F. Aden, a Canberra B.2 and above all, two Vulcans of 83 Squadron—that attention was chiefly focussed.

At 3.30 p.m. the crowds were cleared from the apron and Sir Evelyn Baring, the Governor of Kenya, arrived—in the best air display tradition—by helicopter from Government House; this was a Spartan Air Services (Eastern) Bell 47G2 and the only helicopter operating in East Africa. Sir Evelyn made a protracted inspection of the aircraft drawn up on the apron before reading a message from the Queen Mother indicating her "great distress that it has not been possible for me to open the airport today." The Governor then formally declared the Embakasi airport open, and almost immediately *Miss Kenya*, Mr. John Carberry's 1924 Airdisco-powered (and overheating) D.H.51 took off from a few feet of the 10,000ft runway to open the display. This first aircraft to be registered in Kenya was followed by the smart black-and-white Cessna 180s of the Kenya Police Air Wing which demonstrated message pick-ups, supply-dropping and Alsatian close-support for apprehending criminals. If this smacked of the recent troubles in Kenya it was a turn nevertheless hugely appreciated by the Africans. It was followed by two Piper Cubs of Airspray, Ltd., which poured liquid and dry chemical over the runway from an altitude of very few feet. Demonstrations by a Macchi 320, Cessna 182, and a pair of cavorting Chipmunks rounded off the light aircraft part of the display.

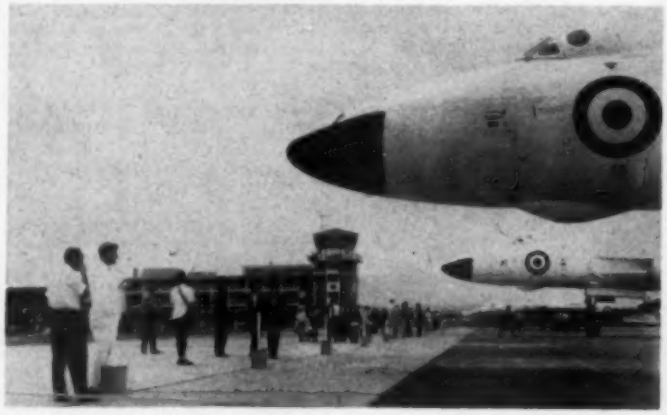
Next came the Directorate of Civil Aviation's equipment-packed Heron (it is used for checking flying and radio aids) with an item strictly for the cognoscenti—it flew a two-minute square on instruments to demonstrate blind-flying technique. After this, the other airliners: Air India's L.1049G, which made a graceful pass over the runway; and B.O.A.C.'s Comet 2E which, with its mixed bag of Avons, demonstrated a take-off climb performance, on a hot afternoon at 5,300ft a.m.s.l., that easily surpassed anything seen at Embakasi—or anywhere in Kenya—before.

Under the crown on the royal dais, His Excellency the Governor of Kenya, Sir Evelyn Baring, opens Embakasi airport. The opening symbol was a movement of the throttles in the DC-3 throttle box on his left.

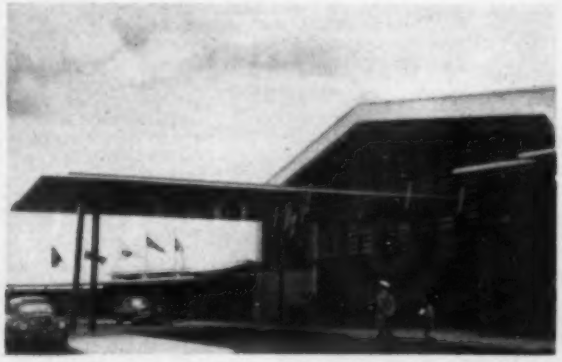
So to the final demonstration, by aircraft of the R.A.F. First, a Shackleton, gainsaying in the air its ponderous appearance on the ground; then a Vulcan, blistering in 115 n.m. from Kilimanjaro's crater in 13 brief minutes before coming in to stream its parachute on landing. Three Vulcans took part in the opening; they had positioned at Entebbe the previous day and two had flown-in earlier to take part in the static display

Finally came a display of aerobatics by a Canberra of 139 Jamaica Squadron and a scintillating exhibition from a Venom FB.4 of loops, rolls, an inverted pass and a vertical figure of eight. The British visitors may have seen it all before, but to Kenyans—white, brown or black—it was an exciting and inspiring sight. Perhaps the memory of it lasted during the congested miles of road—so quickly covered that morning—back into Nairobi.

Vulcans were a novel sight for most of the 20,000 spectators. The jets were the highlight of the air display.

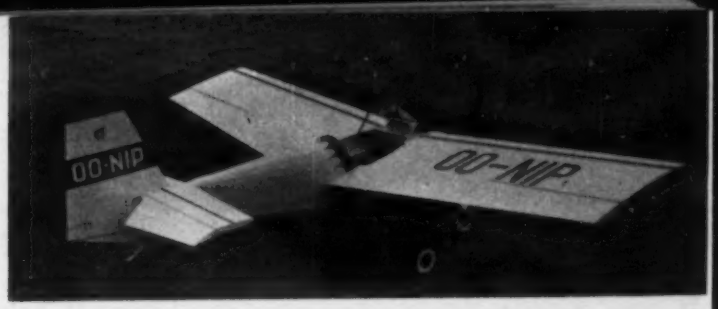


Africans (left) who had worked on the airport installations received privileged positions at the opening, but many travelled long distances for the ceremony. (Right) Windows in the airport buildings are designed to avoid direct sunlight. The shade over the entrance can be very welcome both from sun and heavy rains.



Club and Gliding News

THE NEW TIPSY



FOR very many years the thoughts of Mr. E. O. Tips, managing director of Avions Fairey, Gosselies, Belgium, have been directed towards the idea of a new ultra-light aeroplane. The culmination of these thoughts, and of the subsequent formal design and construction effort, was the recent appearance of the Avions Fairey Tipsy Nipper, with a span of less than 20ft.

At present undergoing performance and endurance tests and powerplant adaptations, the prototype Tipsy Nipper is to be followed by a small batch of development aircraft of this type. It is the company's intention to put a thoroughly tested aircraft on the market; and they expect to be able to accept orders for kits of parts in about three months time; followed by orders for complete aircraft. Tooling is already partly complete.

The airframe has been designed to comply with A.R.B. regulations for the semi-aerobatic category. The wings are of wooden, one-piece construction, with a single spar of constant-width rectangular section. Ribs are of simple Warren-girder type, and consist of spruce strips reinforced with ply gussets. Leading edges of the wing are covered with 1 mm ply.

Access to the cockpit is by means of a novel light-alloy flap on the port side which folds down aft of the spar and contains a footstep. Normally this flap is raised, forming part of the wing. The wing as a whole is easily detachable, a feature intended to facilitate towing the aircraft behind a car (with the wings supported on a roof cradle).

The fuselage is a conventional, tubular-steel, bronze-welded structure. The nosewheel undercarriage gives good visibility on the ground, the nosewheel being steered by means of the rudder pedals for taxying. The wheels themselves are of simple and light construction, with Nieman rubber-ring shock absorbers, and main-wheel brakes (lever-operated from the control column).

The light-alloy fuel tank forms the upper fuselage fairing behind the engine, and also supports the instrument panel and front windscreen-attachment points. Engine cowling and propeller spinner are of moulded glass-fibre, as is the lower fuselage fairing. Both cowling and fairing are easily detachable for accessibility.

Powerplant chosen for the prototype Nipper is a modified version of the Volkswagen car engine. An alternative choice for production machines is the Porsche car or industrial engine.

Of particular interest are the detailed plans already made by Avions Fairey for the supply of kits of parts for amateur constructors who wish to build the Nipper. For a provisional price of £375 ex Gosselies it is intended to provide a packed kit including finished fuselage structure, undercarriage, metal rudder ready for fabric-covering, controls and fittings, fuel tank, untrimmed glass-fibre fairings, windscreen, footstep flap, wooden parts cut to approximate sizes, three-ply sheets, working drawings and illustrated assembly brochure. On the inside surfaces of the packing-case panels the outlines of spars, ribs, ailerons, fin, tailplane, elevators and other components will be marked, enabling the panels to be incorporated in construction jigs.

Not included in the kit are engine and cowling, propeller, instruments, fabric, dope and paint. These would normally be obtained locally, but can be supplied at extra cost by Avions Fairey if required.

Top, simplicity in design is the keynote of the diminutive Tipsy Nipper single-seater Span is only 19ft 8in.

Centre, scale is provided in this photograph of the prototype machine by pilot Bernard Neefs. The engine is a Volkswagen.

Right, the novel folding flap containing the footstep for access to the cockpit. The simple instrument-panel is mounted on top of the wing mainspar.

A Popular Flying Association spokesman in London told *Flight* last week that plans for the Nipper had not yet been submitted for approval by the Association. British purchasers would presumably have to pay the normal 17½ per cent import duty on the aircraft or kit, plus freight charges. No special import licence would be needed.

Avions Fairey Tipsy Nipper (Volkswagen engine)

Dimensions: span, 19ft 8in; length, 14ft 9in; height, 5ft 3in; empty weight, 360 lb; max. designed weight, 660 lb; wing area, 80.5 sq ft; aspect ratio, 4.8.

Estimated Performance: take-off and landing speed, 38 m.p.h.; take-off distance, 150 yd; landing distance, 100 yd; cruising speed, 65 m.p.h.; maximum speed, 75 m.p.h.

THE GLIDING YEAR

"THE best run of gliding weather in all history" and an expansion of the gliding movement in every direction were reported by Mr. Philip Wills, chairman of the British Gliding Association in his report for 1957 to the annual general meeting of the Association at Londonderry House on Saturday, March 15. Eleven U.K. and British national gliding records were broken; and 25 Gold C and 12 Diamond leg flights were achieved.

During the year, a total of 20,344 hr was flown by member-clubs, from 120,024 launches. These figures showed an increase of 5,618 hr and 20,595 launches compared with those for 1956. In addition to this activity, the Air Training Corps had reported 64,659 launches and 4,538 hr; and the Corps had trained 1,063 cadets up to B Certificate standard.

Five new clubs had been elected to associate membership during 1957, and there were now 18 full-member clubs and 18 associate-member clubs, four of which were overseas. Clubs in Dorset, Halifax, Hertford, Ipswich and Plymouth and for B.E.A. employees were now in process of formation.

The Kemsley Flying Trust had continued its good work; loans totalling £5,896 had been advanced to 18 gliding clubs and groups during the year. In addition, further loans totalling £7,665 had been approved and three of these involved the development of new gliding sites.

"The most important single task undertaken in 1957," Mr. Wills stated, "was the taking over, at the request of the clubs concerned, of negotiations for the acquisition of security of tenure at Lasham. The last time such a thing occurred was in 1933, when the B.G.A. successfully negotiated a lease for Sutton Bank with the Ecclesiastical Commissioners. It is to be fervently hoped that we shall again be successful and thus be able to bring stability to a group of clubs which currently represents about 20 per cent of the whole civil movement."

Concluding his report by considering the future, the chairman said that 1958 might prove a crucial year. The Ministries were disposing of a large number of airfields, including those on which some of the most promising British clubs were operating. Apart from Lasham, the clubs affected were the Kent Club at Detling, the Coventry Club at Edgehill, the Newcastle Club at Usworth and the Cornish Club at Perranporth. It was true to say that, by the time of the next annual general meeting of the Association, the shape and size of the British gliding movement would have been determined for the next generation.

SERVICE AVIATION

Royal Air Forces and Naval Flying News

Below decks in an aircraft carrier: a Whirlwind being pushed on to one of the aircraft lifts, ready for raising to the flight deck, in H.M.S. "Bulwark" during Exercise Maple Royal I, held recently in the Caribbean.

2nd T.A.F. Nuclear Capacity

A STATEMENT issued from 2nd T.A.F. headquarters on March 12 and signed by the C-in-C., Air Marshal Sir Humphrey Edwardes Jones, said that R.A.F. aircrew in West Germany are trained in the use of nuclear weapons. It did not follow, however, that these were carried in their aircraft on training flights. The statement referred to last year's White Paper on Defence, which said that 2nd T.A.F. would be given nuclear capacity.

Winged Escort

BY a striking coincidence, the commanders of the three frigates due to escort the Queen and the Duke of Edinburgh when they sail to Amsterdam in H.M.Y. *Britannia* next Monday are all Naval aviators. Capt. H. R. B. Janvrin, who commands H.M.S. *Grenville*, is an observer who took part in the F.A.A. attack on Taranto; and Cdrs. J. L. W. Thompson and K. Lee-White, commanding H.M.S. *Pellew* and *Paladin* respectively, are both pilots.

R.N.Z.A.F. 21st Anniversary

ON March 29 the R.N.Z.A.F. is celebrating the 21st anniversary of its formation—the actual date falling on April 1—with an "open day" at Ohakea marked by a flying display and static exhibition. Air Chief Marshal Sir Ralph Cochrane, who was first C.A.S. of the R.N.Z.A.F. when it was formed in 1937, will be attending as guest of the New Zealand Government; and Air Marshal the Earl of Bandon, C-in-C. F.E.A.F., is to represent the Air Council. A Valiant from Bomber Command will be taking part in the air display, piloted by W/C. L. H. Trent, who is New Zealand's only surviving air V.C. The R.A.A.F. will also be participating.

Senior Postings

TWO senior appointments, one in Air Ministry and the other at SHAPE, have been announced. A. Cdre. W. P. Sutcliffe becomes Director of Intelligence at Air Ministry this month and G/C. C. C. Morton the Deputy Chief Signals Officer at SHAPE with the acting rank of air commodore.

A. Cdre. Sutcliffe began his R.A.F. flying career in 1931 with No. 207 Sqn. and during the war flew with Nos. 101, 82 and 110 Sqns. in Bomber Command, winning the D.F.C. when commanding No. 110 in 1940-41. Among his post-war appointments has been the command of R.A.F. Wittering, and he took part in last year's nuclear tests in the Pacific.

A. Cdre. Morton flew as a pilot with Army co-operation squadrons for three years after leaving Cranwell, but in 1937 went back there to take the Electrical and Wireless School course, after which he embarked on a signals career. Since 1956 he has been Deputy Director of Signals (A) at Air Ministry. He was made C.B.E. in 1946.

Aden Operations

REFERRING to the work of R.A.F. squadrons based at Aden the Air Minister, Mr. George Ward, said in the debate on the Air Estimates (reported on p. 361 of this issue) that he did not think it was generally realized how much flying is done by these squadrons. In the first two weeks only of this month, 14 air supply sorties had been made in Beverleys and 31 in Pembrokes and Pioneers; and there had been 71 troop-carrying and communications sorties in Valettas and 160 in Pembrokes and Pioneers, in addition to operational strikes by Venoms and reconnaissance by a variety of aircraft, including helicopters.

S/L. C. I. Blythe (right) with his wife Maureen and the U.S. Air Attaché, Brig-Gen. F. B. James, after receiving the U.S. Air Medal in London on March 7 for meritorious service during U.N. operations in Korea.

Out of Indentures

NEARLY 800 aircraft and administrative apprentices and boy entrants from R.A.F. Technical Training Command schools start their regular Service careers late this month or early in April, when passing-out parades are held at Halton, Locking, Hereford, Cosford and St. Athan. The parade at Locking, on April 1, when some 40 apprentices of the 80th entry to No. 1 Radio School pass out, will be taken by the A.O.C-in-C. Technical Training Command, Air Marshal Sir Arthur McDonald; and that at Halton the following day, when 185 apprentices of the 80th entry to No. 1 School of Technical Training ceremonially complete their training, by Air Marshal Sir Gilbert Nicholetts, Inspector-General of the R.A.F. At Cosford next Tuesday, when 285 boy entrants of the 29th entry pass out from No. 2 School of Technical Training, the reviewing officer will be A. V-M. J. G. W. Weston, A.C.A.S. (Signals).

Recent Postings

AMONG R.A.F. appointments recently announced by Air Ministry are the following:—

G/C.s E. A. Harrop to H.Q., Maintenance Command, for technical staff duties; and S. W. Lane to AAFCE, for staff duties.

W/C.s A. S. Duff to H.Q., Fighter Command, for administrative staff duies; G. M. Gibson to No. 16 M.U., for administrative duties; A. J. Houston to Air Ministry, for duty in the Department of the Chief of the Air Staff; D. McDermott to H.Q., Technical Training Command, for technical staff duties; W. J. Nightingale to No. 11 M.U.

S/L. A. C. Hollingsworth to No. 2 Air Navigation School, to instruct (with the acting rank of wing commander).

Bristol U.A.S. Dinner

ON April 25 the fifth annual dinner of Bristol University Air Squadron is being held at the Hawthorns Hotel, Bristol, at 7.30 for 8 p.m. Members and ex-members are invited to attend and should contact the Mess Secretary, Officers' Mess, Bristol University Air Squadron, 82 Woodland Road, Bristol 8.

IN BRIEF

Air Marshal the Earl of Bandon recently presented silver replicas of Whirlwind and Sycamore helicopters to the C.O.s of Nos. 155 and 194 Sqns., S/L.s R. C. Penning and F. Barnes, in recognition of their support in Malayan anti-terrorist operations.

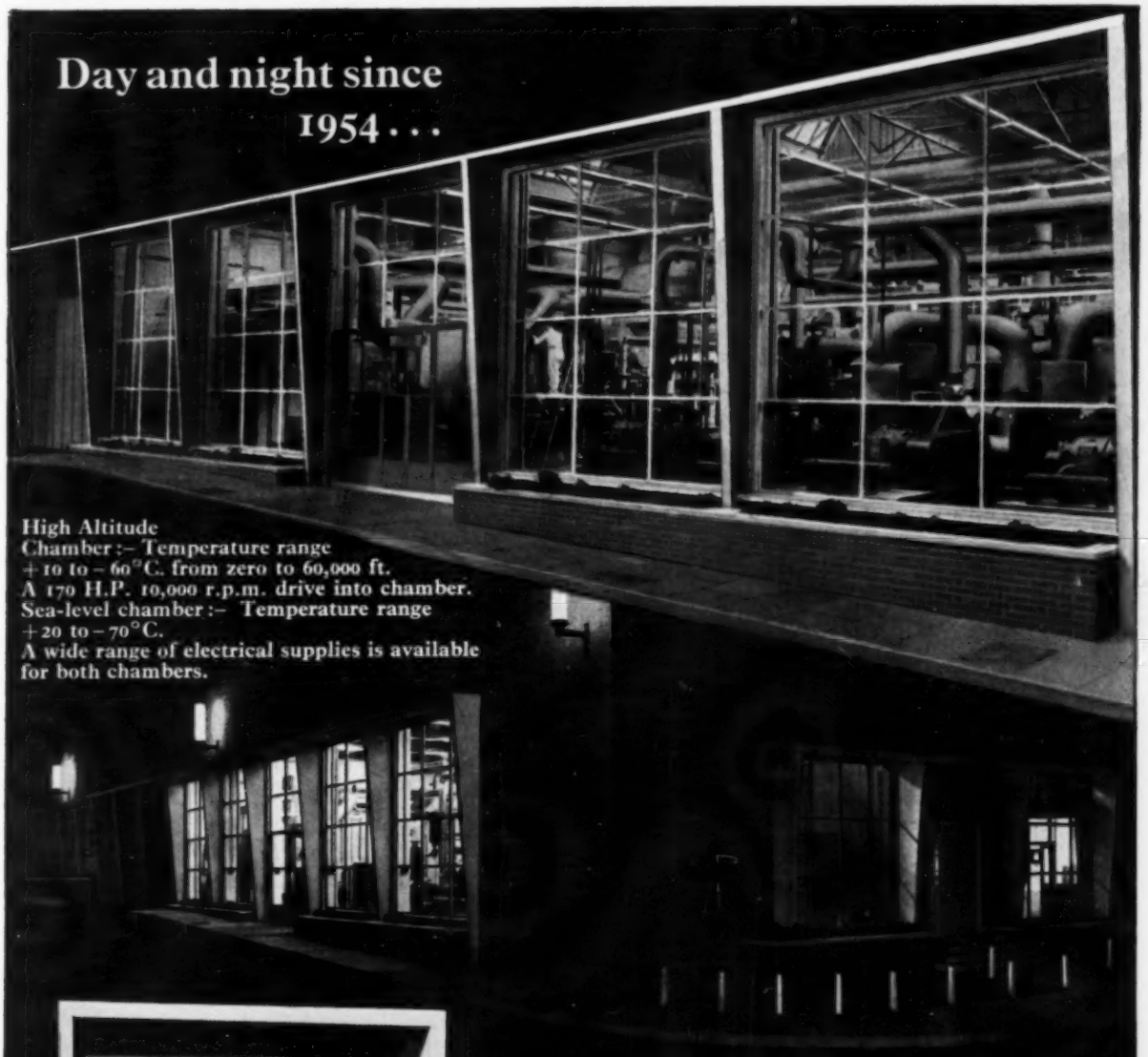
* * * * *

Two Valiants of No. 90 Sqn., captained by W/C. F. S. Hazlewood and S/L. C. R. C. Spencer, recently visited Manila and Saigon while on training in F.E.A.F.

* * * * *

Fourteen officers of No. 10 Specialist Navigation Course of the R.C.A.F. Central Navigation School at Winnipeg are spending 15 days in this country to study the latest navigational and electronics developments in the R.A.F. They arrived on March 12 by R.C.A.F. North Star and are due to return to Canada by R.C.A.F. Comet on March 26.

Day and night since 1954 . . .



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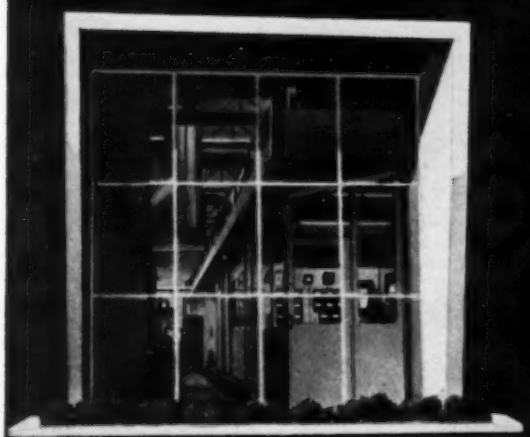

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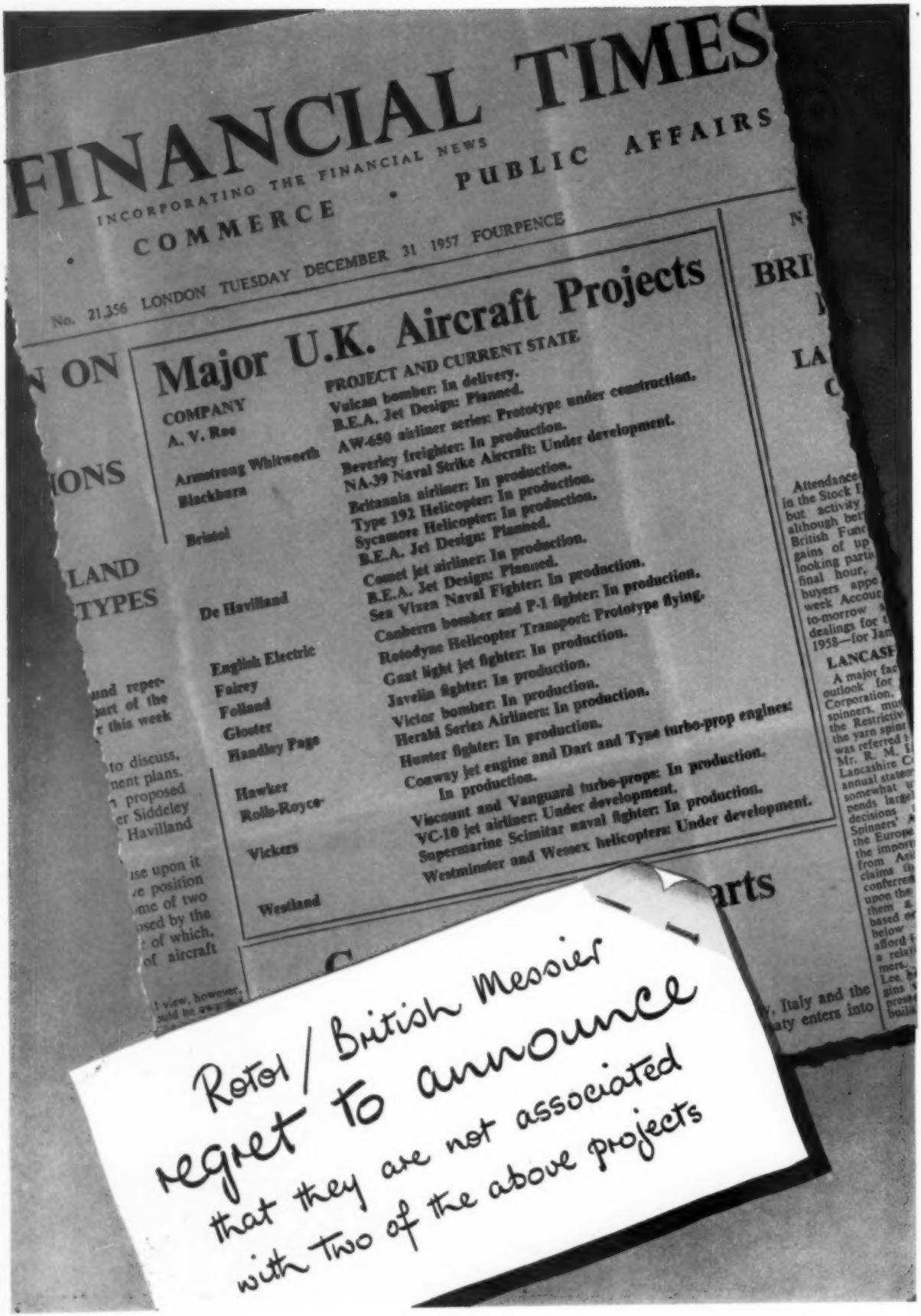

FINANCIAL TIMES

INCORPORATING THE FINANCIAL NEWS

COMMERCE • PUBLIC AFFAIRS

No. 21,356 LONDON TUESDAY DECEMBER 31 1957 FOURPENCE

Major U.K. Aircraft Projects

COMPANY	PROJECT AND CURRENT STATE
A. V. Roe	Vulcan bomber: In delivery. B.E.A. Jet Design: Planned.
Armstrong Whitworth	AW-650 airliner series: Prototype under construction.
Blackburn	Beverley freighter: In production. NA-39 Naval Strike Aircraft: Under development.
Bristol	Britannia airliner: In production. Type 192 Helicopter: In production. Sycamore Helicopter: In production. B.E.A. Jet Design: Planned.
De Havilland	Comet jet airliner: In production. B.E.A. Jet Design: Planned. Sea Vixen Naval Fighter: In production. Canberra bomber and P.1 fighter: In production.
English Electric	Rotodyne Helicopter Transport: Prototype flying.
Fairey	Gnat light jet fighter: In production. Javelin fighter: In production.
Folland	Victor bomber: In production.
Gloster	Herald Series Airliners: In production.
Handley Page	Hunter fighter: In production.
Hawker	Conway jet engine and Dart and Tyne turbo-prop engines: In production.
Rolls-Royce	Viscount and Vanguard turbo-props: In production.
Vickers	VC-10 jet airliner: Under development. Supermarine Scimitar naval fighter: In production.
Westland	Westminster and Wessex helicopters: Under development.

Rotol / British Messier regret to announce that they are not associated with Two of the above projects

From a painting by Roy Cross

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Missile auxiliary power

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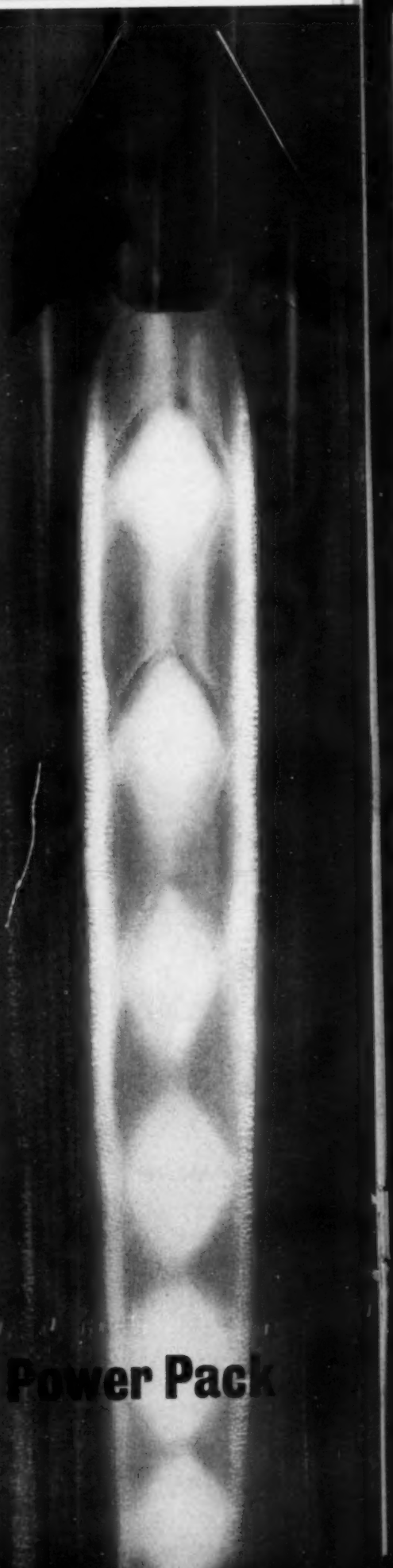
For qualified engineers who would like to work on advanced equipment of the type illustrated, the opportunities are outstanding. Write to the Personnel Officer for information.



Plessey Guided Weapon Power Pack

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Helicopters of the World

A "FLIGHT" SURVEY OF CURRENT AND PROJECTED TYPES

GREAT BRITAIN

Bristol Aircraft Ltd.

Filton, Bristol.

Sycamore Over 150 Sycamores have been delivered, and production is at the rate of approximately four aircraft per month. All parts of the airframe have overhaul periods of 800 hours or more, and the Alvis Leonides engine overhaul period (a Leonides is invariably fitted) is at present 400 hours.

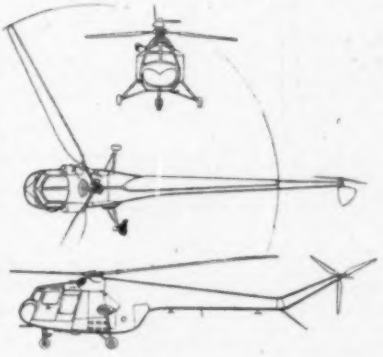
The basic Sycamore is a five-seater. In addition to the main cabin, which has a volume of 100 cu ft, it has a luggage compartment of 20 cu ft and is provided with all the fixed fittings needed to convert it to any of six major rôles, viz., search and rescue, air ambulance, passenger transport, freight transport, aerial crane and dual instruction. In addition to these primary capabilities, the Sycamore is suited to a variety of special tasks, and to equip it for any one of these, or to change it from one to another, is a simple operation. For all rôles the aircraft is normally equipped with three folding canvas seats for passengers and one seat beside the pilot which can be turned to face rearwards.

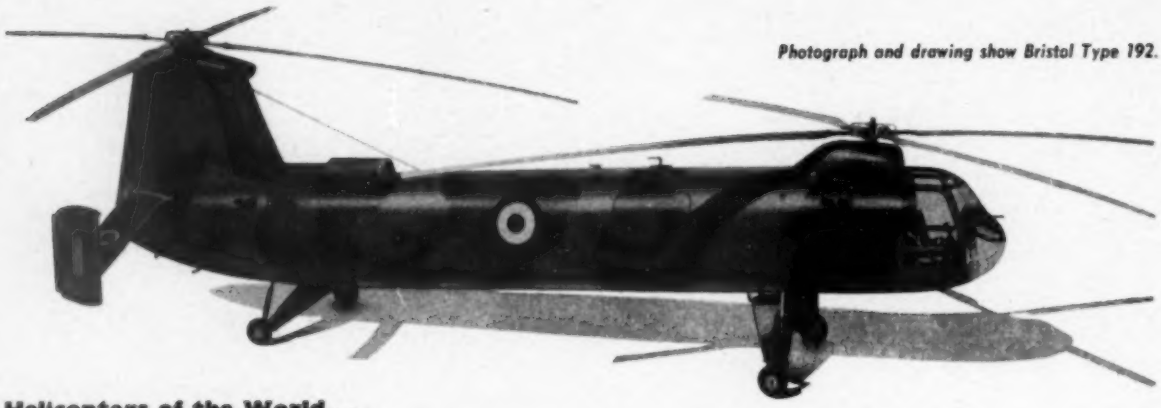
The main rotor blades are attached to the sleeves on the rotor head by a light, strong root-fitting formed by interleaving steel plates with the spar laminations. Tie-rods take the centrifugal force directly in tension, but are flexible in torsion.

The blade levers are connected by ball joints to the arms of a control spider carried by taper roller bearings on a control axle mounted in a control cone. The cone is moved up and down by the collective pitch control lever, the axle and spider moving with it and changing the pitch of all blades collectively; an irreversible mechanism prevents blade loads coming back to the control stick. When the control axle is tilted about its cup-and-ball joint by the cyclic pitch control, however, the pitch is changed cyclically, minimum pitch being where the spider arms are lowest and maximum pitch diametrically opposite. Inter-blade and drag-hinge dampers neutralize rotor vibration. The blades are supported when at rest or turning slowly by droop stops which ensure the necessary clearance between the blades and the fuselage for starting and stopping in high or gusty winds. When the rotor speed exceeds approximately 100 r.p.m., these stops are withdrawn, leaving the full freedom of movement which is essential for flight. These stops ensure that the minimum clearance between the main rotor

INDEX: PAGE 402

Above and below, Bristol Sycamore.





Photograph and drawing show Bristol Type 192.

Helicopters of the World . . .

blades and the ground is 6ft 10in. The rotor can be started or stopped in winds of at least 50 kt and on board a ship rolling through 24 deg.

The rotor gearbox is immediately below the main rotor hub and contains two pairs of straight spur gears of 4.35 : 1 and 2.56 : 1 ratios, giving a total speed reduction between engine and main rotor of 11.15 : 1. The main wheel, which is attached to the rotor hub, is carried on a steel axle directly attached to the aircraft structure, while the remaining gears are carried by the light-alloy gearbox attached to the base of the axle. The tail rotor drive is also taken from this gearbox.

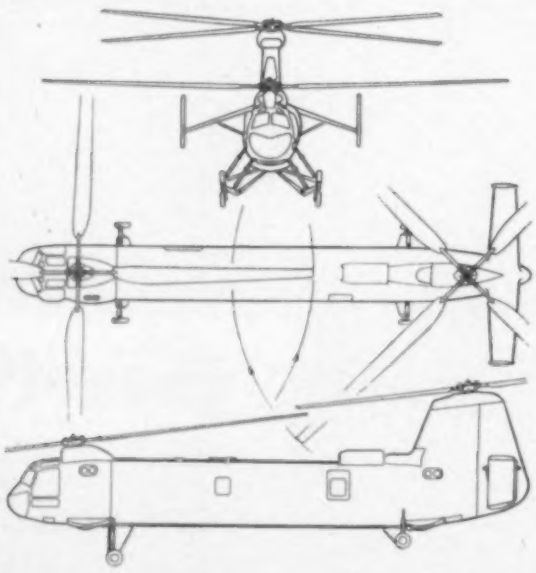
The Alvis Leonides engine is mounted with the crankshaft axis vertical, and the complete unit (including the fireproof cowling) is supported on a flexible mounting which isolates engine vibrations. The crankshaft carries a single-plate centrifugal clutch, which begins engagement automatically at approximately 1,000 r.p.m. and the clutch casing provides a hub for the cooling-fan blades. The entire power unit is isolated in a fireproof casing, and fire extinguisher equipment is provided in accordance with standard requirements. The engine control is linked to the collective pitch lever in the cockpit, so that power is automatically controlled by the rotor pitch setting. Power requirements are not purely a function of rotor pitch, however, and a fine adjustment of engine power is obtained by a twist grip action of the pitch lever handle. Cooling air enters the engine compartment through a grille immediately in front of the main rotor hub and helps to cool the rotor gearbox before passing through the engine cowling and leaving the fuselage.

The main drive is taken from the clutch to the rotor gearbox by a vertical torque shaft, which is flexibly mounted to isolate the gearbox from engine impulses. The drive for the tail rotor is taken from this gearbox through a small spiral bevel gear incorporated in the gearbox and terminating in a universal joint to which the tail rotor shaft is attached. The tail rotor drive consists of a series of tubular steel shafts carried by a number of steady bearings and coupled together by means of double universal joints to preserve a constant angular velocity in the drive, which has a maximum speed of some 2,200 r.p.m.

A relatively high rotor speed is claimed to make for smoothness of flight and to confer a marked safety advantage in the event of power failure, in that the large degree of kinetic energy stored in the rotor gives the pilot a valuable extension of time in which to reduce collective pitch and go into autorotation.

● Rotor diam., 48ft 7in; overall length (blades folded), 46ft 2in; empty weight (passenger version), 4,130 lb; disposable load (passenger version), 1,270 lb; max. speed, 127 m.p.h.; max. economical cruising speed, 91 m.p.h.; max. endurance (economical cruise, normal fuel), 2.95 hr; service ceiling, 15,500ft.

Type 192 Described by the makers as Europe's biggest military helicopter, the turbine-powered, twin-rotor Type 192 is in production for the Royal Air Force. It will serve for freight transport, ambulance and search and rescue. The power units are two Napier Gazelle Series 2 gas turbines producing 920 s.h.p. apiece, with emergency power ratings of up to 1,650 s.h.p. for single-engined flight.



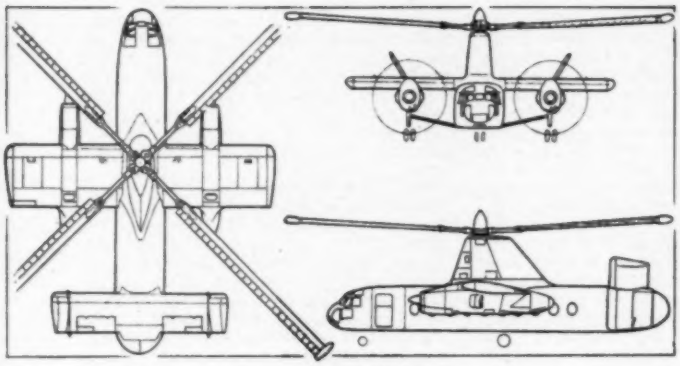
On a long-range trooping operation of 250 nautical miles, 18 fully armed troops can be carried with a crew of two. On shorter-range operations, as many as 25 troops can be lifted. To aid quick disembarkation in hovering flight, a scrambling net is attached to the lower sill of the door in the forward starboard side of the fuselage. In the ambulance rôle, the 192 will carry 8 to 12 stretcher cases, arranged in tiers of three along each side of the cabin—in addition to three "sitting wounded." Medical supplies, electric points for electrically heated blankets and blood transfusion equipment will also be carried. When the helicopter is flying over difficult terrain where landing is impossible, stretchers can be winched up to the machine as it hovers a few feet above the ground. In the freight rôle, the aircraft carries a maximum concentrated load of 4,000 lb and a maximum distributed load of 6,000 lb. A winch, with a maximum load of 600 lb, is used to take supplies and equipment aboard when the aircraft is in hovering flight. Awkward loads—up to a weight of 5,350 lb—which cannot be carried in the cabin are slung from a strong point under the fuselage; this strong point can also be used for towing loads. The release gear for underslung loads is operated either mechanically or electrically by the pilot. For search and rescue the aircraft is equipped with a spring-balanced door which can be opened and closed in flight. A winch, attached to the underside of the upward-swinging door, can hoist loads up to 600 lb and is operated either by the pilot or a crewman stationed near the door.

The 192 is fully equipped for day and night instrument flying and provision has also been made for an automatic pilot and dual controls. Single-engine safety is ensured by a synchronizing shaft which interconnects the two engines, keeps the rotors in proper phase relationship, and permits both rotors to be driven by one engine in case of emergency.

Flying in the twin-engine condition, the engines are each limited to 920 s.h.p. and, as the one hour power of the Gazelle is 1,300 s.h.p. an ample reserve of power for normal operations and single-engined flight is claimed. In the event of one engine failing, an emergency rating of 1,650 s.h.p. on the remaining engine can be used.

For operation in gusty conditions, each rotor hub is fitted with centrifugally-operated droop stops and anti-coning stops for start-up and run-down in high winds, and a hydraulically operated rotor brake is capable of stopping the rotors from 100 r.p.m. in 16 seconds. For cold weather operations, the windscreen has electric thermal de-icing. The crew stations are heated.

● Rotor diam., 48ft 8in; overall length (max.), 89ft 9in; gross weight, 18,000 lb; max. speed, 138 m.p.h.; service ceiling, 13,250ft; hovering ceiling without ground effect, 8,000ft; vertical rate of climb, 500ft/min; troop-carrying capability, up to 23 armed troops for a still-air range of 130 n.m.; freight capability, 6,000 lb for a still-air range of 125 n.m.; ferrying capability, over 600 n.m.



Fairey Rotodyne.

Above and below, Fairey Ultra Light.

Helicopters of the World . . .

The Fairey Aviation Co. Ltd.

Hayes, Middlesex.

Rotodyne This unique and highly promising transport helicopter was fully described in *Flight* of August 9 last, and a further appraisal appeared in our issue of December 20. In the original description it was remarked that the Rotodyne (the first prototype of which has completed several hours of flying) is an extrapolation of the original Gyrodyne principle: power-driven rotor for vertical flight, with propellers for propulsion and autorotating rotor for forward flight. Where the Rotodyne differs from its predecessor is in having a considerable wing to share the lift with the windmilling rotor. The essential principles which led to this particular configuration require to be briefly stated for a proper understanding of the Rotodyne. It was chosen firstly as being the best compromise to give VTOL ability with a practical cruising speed of 160 kt.

The bane of the helicopter designer in search of speed has always been the stalling of the retreating blade, the true airspeed of which is the algebraic sum of the rotational velocity of the rotor and the forward speed of the aircraft. In other words, as aircraft speed rises the true airspeed of the retreating blade falls. Since there are practical limits to blade r.p.m. (imposed by centrifugal loading) and blade area (because of weight and drag) the only palliative for blade-stall is to reduce the loading and thereby the stalling speed of the critical inner portion. In the Rotodyne, at cruising speed, the wing carries 60 per cent of the load.

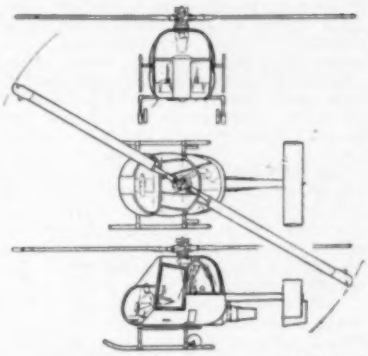
Again, a propulsive rotor requires more incidence—and is, in any case, a device far removed from optimum efficiency in the horizontal plane, so that propellers are a logical corollary to an "off-loaded" rotor.

Inevitably, a convertiplane must carry dead weight from one form of flight to the other—the wing and tail at take-off, the rotor drive while cruising. In the case of the Rotodyne, however, there is no cumbersome irreversible mechanism for the rotation of wing and/or rotors through ninety degrees, while there is some compensatory saving in the absence of a tail rotor.

A single rotor was chosen by Fairey because of the greater reliability which it confers and because of the shorter time required to prove its reliability to licensing authorities. The tip-jet drive was adopted to simplify the transmission problems of a large rotor by the elimination of torque and gearing—6,000 h.p. gearing in this case. As a "bonus," tip drive also makes drag hinges unnecessary.

As a result of the closest co-operation between the airframe and engine designers, the Napier Eland NEl.7 turboprop, with its economy, reliability and excellent development potential, has been specifically designed to meet the requirements of the Rotodyne. Engine power may be absorbed either in the propellers or in the auxiliary air compressors.

The auxiliary compressor, driven through a hydraulic clutch, draws atmospheric air through an intake in the upper surface of the wing and delivers compressed air to the Fairey pressure-jet units at the rotor blade tips. Rotating seals are provided at the rotor head. Each compressor serves one diametrically-opposed pair of jet units and this, in conjunction with similarly duplicated fuel services,



minimizes power loss in the event of failure of one engine. Fuel is supplied, under pressure, to the combustion chamber of each tip-jet unit, the fuel/air ratio being governed by a variable-datum automatic regulator. Ignition of the fuel/air mixture is effected by two high-energy igniter plugs in each unit.

Rotor speed, being independent of engine speed, is variable over a wide range, making for ease of control, and the smoothness of this type of drive makes a valuable contribution to passenger comfort. The relatively high specific fuel consumption of the jet units is more than offset by the short duration of powered-rotor flight and low installed powerplant weight.

A rotor-driven accessories gearbox ensures that the essential flying controls are unaffected in the event of a total power failure when airborne.

Questioned by *Flight* as to the main applications of the Rotodyne, Dr. G. S. Hislop, deputy chief engineer and chief

Fairey Rotodyne (prototype with temporary undercarriage scheme).

Helicopters of the World . . .

designer (rotating wing) of the Fairey Aviation Company, commented in these terms: "In our approach to this aircraft, as the natural result of the B.E.A. interest, the preparation of the basic requirements and our thinking have been directed towards the civil market, and the requirements of a civil transport machine have dominated our approach in many respects. For example, great emphasis has been laid on meeting the one-engine-failed performance requirement, and a great deal of thought has gone into the handling and control problems in this case. This approach has perhaps tended to lengthen our task in designing and building the prototype, since for a purely research aircraft it would have been possible to have omitted certain of these design features. In my view this approach would have been quite wrong, as by-passing fundamental handling, control and performance requirements at this stage would have resulted in having to do a great deal of the work again—and with greater difficulty—when the success of the aircraft as a bare research flying machine had been demonstrated.

We have had firmly fixed in mind that our ultimate objective was to sell the aircraft in the civil market and we have done our level best to meet and anticipate the sort of requirements which will be needed not only by the operators but by the certification authorities. . . .

"Whilst the aircraft is obviously just as suitable for the transport of soldiers or their equipment as for the carrying of fare-paying passengers, the military asked that the fuselage of the second aircraft be made of a cross-section suitable to carry Army vehicles. This, and possible interest for car-ferry work, resulted in the second machine being designed with a larger fuselage."

● Rotor diam., 90ft; fuselage length (internal), 46ft; fuselage length (external), 58ft 8in; gross weight, 39,000 lb; disposable load, 15,500 lb; range with 40 passengers, 310 miles; max. range, 460 miles; cruising speed, 185 m.p.h.

Ultra Light This tiny helicopter has numerous civil and military applications. A Blackburn Turboméca Palouste is the basic powerplant, and there are Fairey pressure-jet units at the tips of the rotor blades. The rotor is driven by the tip-jet units burning fuel mixed with the compressed air fed out through the hollow blades from the Palouste turbo-generator. This simple system is claimed to give the Ultra Light a rate of climb higher than is achieved by any other helicopter in the world. The powerplant is further claimed to start instantaneously on the ground without any auxiliary motors: it burns all grades of kerosine and petrol; it dispenses with the tail rotor, since a tip-driven rotating wing is torqueless; and, most of all, it does away entirely with shafts, gears, clutches, and the complications inseparable from a rotor conventionally driven by a piston engine.

At the centre of the basic structure is a light-alloy box containing a crash-proof fuel tank. From the top of this box stems a rubber-mounted pylon; to the rear is a box-girder boom carrying fins and rudder. The remainder of the aircraft is built around this "core." The boom is split half way down its length by a bolted joint so that the entire aircraft can be broken down quickly into a package 9ft by 10ft 8in by 6ft 6in for air or surface transport. Landing gear consists merely of a pair of tubular steel skids across which porter bars can be inserted so that the aircraft can be carried manually.

The makers state that the rotor blades can be removed and replaced in fifteen minutes and that the engine and complete rotor assembly can be changed in under two hours.

● Rotor diam., 28ft; overall length (less rotor), 14ft 8in; gross weight, 1,800 lb; disposable load, 850 lb; max. endurance, 2 hr 30 min; cruising speed, 95 m.p.h.; vertical rate of climb at s.l., 950ft/min; hovering ceiling (out of ground effect), 5,000ft.

Saunders-Roe, Ltd.

Osborne, East Cowes, Isle of Wight.

Skeeter Mk 12 The Mk 12 version of the Skeeter two-seater light helicopter is in production for the British Army and the German Army and Navy. Certain of the Skeeters for Germany have provision for fitting Napier rocket boost.

The aircraft is of all-metal construction with the exception of the rotor blades. The forward fuselage is a conventional light-alloy structure incorporating a crash-proof tank situated behind the pilots' seats. The centre section, which also constitutes the engine mounting, is fabricated from steel tubes to facilitate engine and transmission maintenance; the rear fuselage is of light-alloy monocoque construction, enclosing the shafting and gearboxes which drive the tail rotor.

The crew of two are seated side-by-side. Full dual controls are available, allowing the helicopter to be flown from either seat, or to be used as a trainer. Seats are individually removable and a long-range tank may be installed in place of the seat normally used by the observer. This seat can be reversed if required, and rearward vision is satisfactory for A.O.P. work. The radio is fitted on the floor between the crew seats. There is provision for two stretchers, externally attached to the sides of the cabin.

The basic aircraft is powered by a normally aspirated de Havilland Gipsy Major 215 helicopter engine (215 b.h.p. maximum one-hour rating). This is installed transversely, the drive for the main rotor being taken from the end of the crankshaft on the starboard side of the aircraft. Fan cooling is provided through a starboard intake. A methanol injection system may be installed if required, and an exhaust-driven turbo-supercharger, which is readily detachable, is available. A rocket booster system (employing concentrated hydrogen peroxide fuel) can also be supplied.

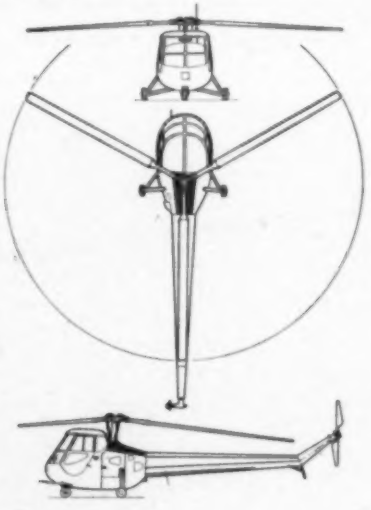
Transmission is via a primary gearbox at the starboard end of the engine crankshaft, an intermediate shaft, and a secondary gearbox mounted centrally above the engine and attached to the fuselage centre-section. The secondary gearbox supports the main rotor shaft. A centrifugal clutch is incorporated in the primary gearbox. This can be overridden by a manual control to enable the engine to be run up independently of the rotor if required. The tail rotor is driven from the secondary gearbox through shafting and two subsidiary gearboxes.

Each of the main rotor blades consists of a wooden secondary structure bonded to a steel tubular spar, the whole being covered with fabric. The leading edge is plywood covered. The three blades may be folded back parallel to, and supported by, the rear fuselage. The two-bladed tail rotor is of "improved wood" construction.

● Rotor diam., 32ft; overall length (blades folded), 28ft 5in; gross weight, 2,200 lb; max. speed, 104 m.p.h.; cruising speed, 100 m.p.h.; max. endurance (normal tankage), 3 hr; service ceiling, 12,800ft; max. rate of climb, 1,150ft/min; hovering ceiling (with ground effect), 5,500ft; hovering ceiling (free air), 2,500ft.

B.531 This is the Saunders-Roe designation for a new helicopter, which can loosely be described as a scaled-up Skeeter. Seating five, the B.531 will be powered by a Blackburn-Turboméca Turmo free-turbine unit of some 450 s.h.p. Development is well advanced and the first example should fly at the S.B.A.C. display in September.

Below and right, Saunders-Roe Skeeter Mk 12.



WIDGEON

The Widgeon is an all-purpose helicopter specially designed for

AIR-SEA RESCUE

AIR AMBULANCE

EXECUTIVE TRAVEL

FREIGHT CARRYING

INSTRUCTION

In addition to the pilot, the Widgeon will seat four passengers, or carry half-a-ton of freight, or lift two fully-clothed and waterlogged men from the sea on its rescue winch. Or, by removing the seats and sliding in two standard type stretchers (securely held one above the other), it may be transformed within four minutes into an ambulance.

The Widgeon is indeed a maid-of-all-work, and is the lowest priced British helicopter of its capacity and type now available

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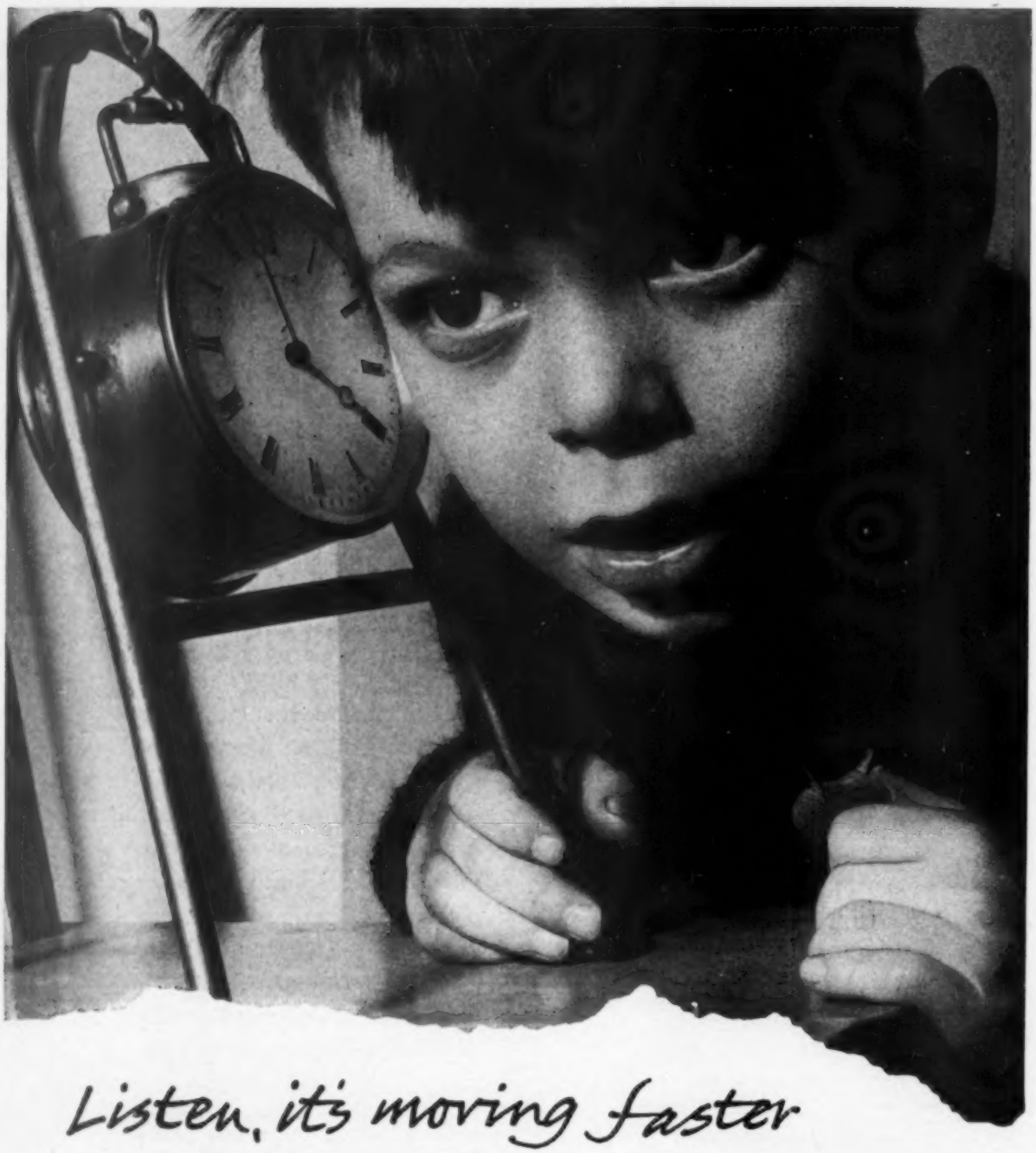


Listen, it's moving faster

He lives in a fast-moving age. Already, achievements meriting a century's span are crowded into his short lifetime. And still—as men extend their knowledge almost to the threshold of Space—the tempo quickens. Quick enough for *him* to see men's most daring ambition realised? That is still not certain. But this International Geophysical Year must bring such an achievement measurably closer.

AVIATION BP SERVICE

The international aircraft fuelling organization of
The British Petroleum Company Limited

salutes the I.G.Y.—year of opportunity

IGY1

Above and right, Westland Whirlwind.

Helicopters of the World . . .

Westland Aircraft, Ltd.

Yeovil, Somerset.

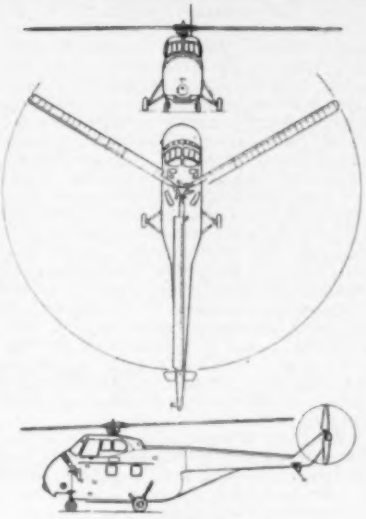
Widgeon The Widgeon five-seater helicopter has been designed for three basic rôles—passenger-carrying, rescue from sea or mountain, and ambulance work—but it is equally suitable for photography, survey, freight-carrying and many other purposes for which helicopters of its class are often utilized.

The cabin has a floor area of 24 sq ft. The fitting of the three rear and two adjustable forward seats has been designed so that they can be quickly and simply removed when the aircraft is required for rôles other than passenger-carrying. The side-by-side front seating is especially advantageous when the helicopter is used for pilot training, for which rôle dual controls are fitted.

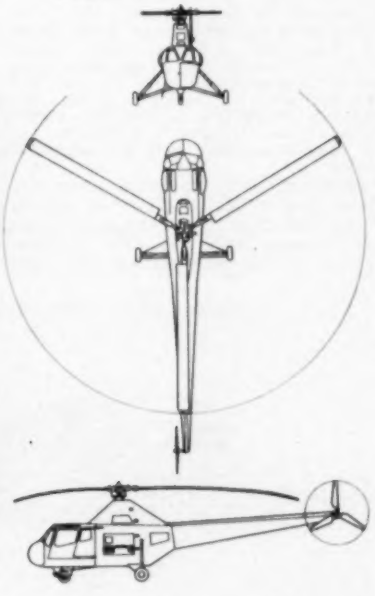
For the standard Widgeon power is provided by an Alvis Leonides 521/1 engine, mounted with the crankshaft vertical, in the centre section of the fuselage. Cooling air is passed over the engine by a fan drawing air from the intake grilles on the rotor pylon and exhausting through the exit ports on the sides of the fuselage. A gauze-covered air intake for the engine is on the right-hand side of the engine bay. A spring-loaded valve admits air from the engine bay should the external intake become blocked with snow or ice, and an intake filter can be fitted if required.

All-metal main rotor blades, with a robust extruded leading-edge spar and light-alloy trailing-edge pockets, are a feature—as on all Westland helicopters. Each blade is matched to master blades and has the advantage of individual interchangeability without the need to replace a complete blade set if one is damaged. The blades can be folded backwards to reduce storage space.

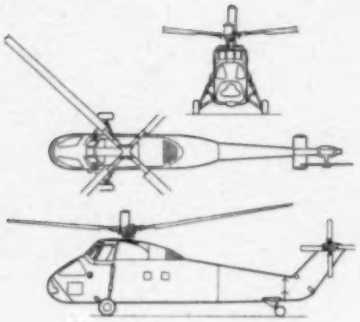
The vertical shaft from the engine drives through a centrifugal clutch, incorporating an engine cooling fan, to the main gearbox. This has two-stage epicyclic gears giving



Below and right, Westland Widgeon.



Left and below, Westland Wessex.



Helicopters of the World . . .

a 14.85 speed reduction for the main rotor and a 2.25 reduction for the tail rotor. A freewheel unit overrides in the event of engine failure, enabling the rotor to continue turning. The gearbox takes the main lifting load of the helicopter. The main rotor head incorporates flapping and drag hinges. A cyclic-pitch control column and rudder pedals are installed in the conventional manner together with a collective pitch lever adjacent to the left side of the seat and incorporating a twist-grip throttle. Spring-loaded trimming gives "feel" to the cyclic pitch stick and a positive central position. The trim can be adjusted fore and aft by a handwheel on the control pedestal and laterally by an electric switch operating an actuator. Cyclic and collective pitch systems are servo-assisted. The hydraulic pump is driven from the tail rotor shaft, maintaining servo control in the event of engine failure. Manual reversion is possible in the event of hydraulic failure.

When the Widgeon is used as an ambulance the triple rear seats are removed and the port side front seat is transferred to a position behind the pilot, for use by a medical attendant. Accommodation is provided for two stretchers, one above the other positioned lengthways in the cabin.

● Rotor diam., 49ft 2in; fuselage length, 41ft 3in; empty weight (passenger rôle), 4,322 lb; gross weight, 5,900 lb; max. permissible speed, 109 m.p.h.; economical cruising speed, 80 m.p.h.; hovering ceiling (10ft wheel clearance) at 5,900 lb, 7,500ft; best rate of climb at s.l., 600ft/min; max. range, 310 miles.

Whirlwind The Whirlwind continues in production for civil and military applications, and offers a particularly attractive performance with the Alvis Leonides Major engine, although the Pratt and Whitney R-1340 and Wright R-1300 are alternatives. The latest Service variant is the HAS.7 anti-submarine helicopter, now standard equipment in the Royal Navy. This version is equipped with "dipping Asdic" detection apparatus and can be armed with a homing torpedo.

The fuselage of the Whirlwind comprises two main assemblies of magnesium alloy semi-monocoque construction. Fuel tanks are under the cabin floor and a firewall isolates the engine from the cabin. The soundproofed cabin can have eight seats—five facing aft and three forward. The standard Whirlwind has two windows on each side of the cabin, but additional windows, increasing the viewing area by approximately 60 per cent, can be fitted if required. The cockpit is raised and has sliding side windows. The pilot's seat is to starboard and fixed fittings are provided to take a co-pilot's seat and dual control. A cyclic-pitch control column and rudder pedals are installed in conventional manner together with a collective pitch lever adjacent to the left side of the seat and incorporating a twist-grip throttle. Cyclic and collective systems are servo assisted. The servo units are operated by the main hydraulic system with both an emergency lateral servo unit and the ability to revert to manual control. A diagonal shaft transmits power through a clutch to a main gearbox centrally mounted above the cabin, carrying the main lifting loads and providing gear reduction for the main and tail rotor and accessory drives. As an added safeguard in the event of engine failure a freewheel unit over-rides and enables the main and tail rotor to continue turning in autorotation.

The four-wheel undercarriage has oleo pneumatic legs and fully castering nosewheels. A Dunlop brake system acts on the main wheels and is operated by toe controls on the pilot's rudder pedals. A parking brake is provided, and a skid to protect the tail rotor.

Eight interconnected bag tanks give a total usable fuel capacity of 145 Imp. gal. Delivery is by engine-driven pump and two immersed booster pumps. For all services a 30-volt d.c. system is employed with air-cooled generator charging a single 24-volt 25-amp-hr battery. The radio compartment is aft of the main cabin and provision is made for V.H.F. STR.9X radio.

Quick removal of Dzus-fastened panels gives access to the main gearbox and flying control system, and the radio bay is reached by removing a single panel on the starboard side. Servicing platforms are built into the fuselage to facilitate inspections of rotor head and gearbox.

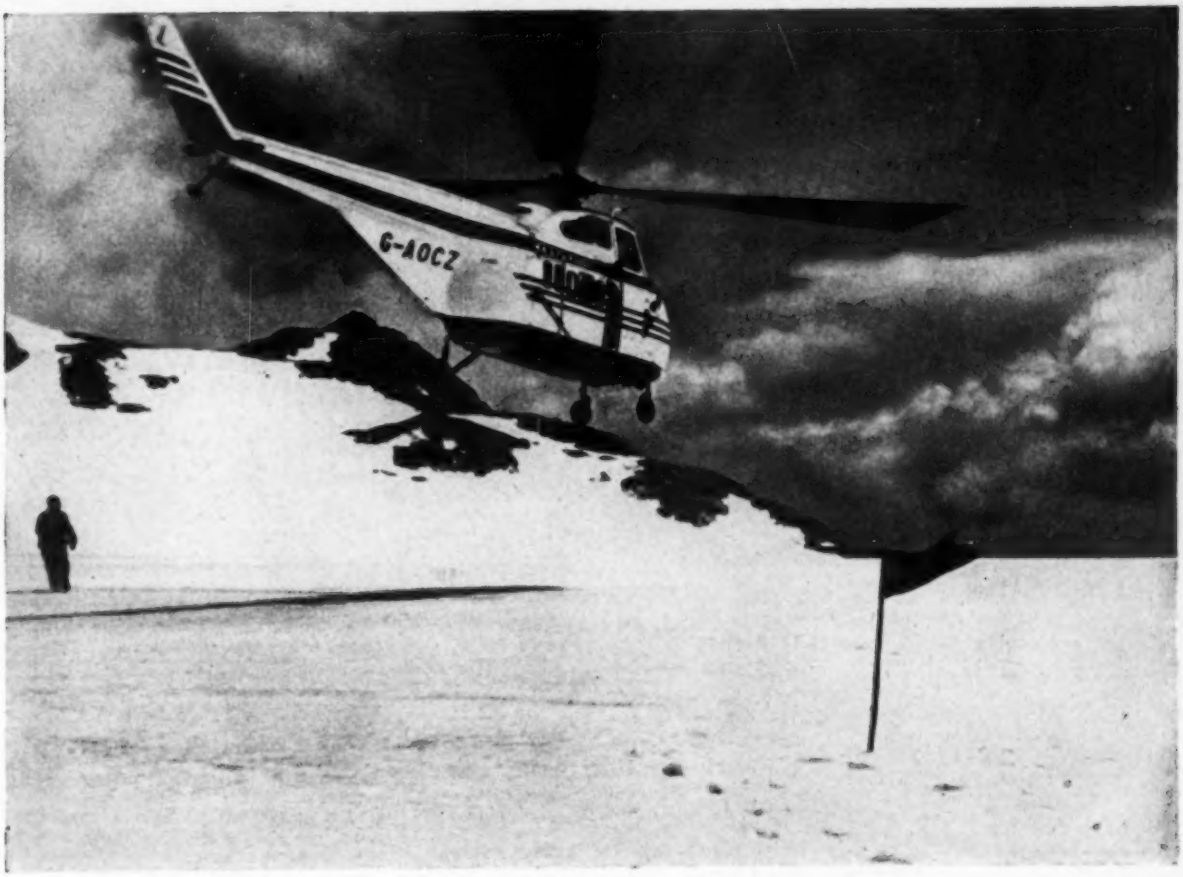
Features of the rotor head include offset flapping hinges giving a wide c.g. range and consequent freedom of loading. Droop restrainers ensure adequate clearance between the blade tips and the fuselage at slow rotor speeds, making starting possible in high and gusty winds. Blade pitch control is transmitted from the hydraulic servo jacks by swash plates and push-pull rods to the blade levers.

Freight up to 2,000 lb, which may be too bulky to accommodate in the cabin, can be carried externally below the fuselage on a sling. An electrical quick-release is mounted on the pilot's control column with a secondary mechanical release on the cockpit floor. Loads are attached with the helicopter hovering above, and can be accurately positioned on landing so that further crane or ground handling is not necessary. Sling installation or removal takes less than ten minutes. An item of extra equipment is the hydraulically powered hoist with a jib mounted above the main cabin door. It will lift two people or a load of 400 lb.

The engine is mounted in the nose and is readily accessible by opening two clamshell doors. The installation ensures easy maintenance and servicing. A complete power-plant change can normally be made in five hours, including time required for fuel-flow test and engine run.

All-metal main rotor blades, made up of a robust extruded leading-edge spar to which are attached light-alloy trailing-edge pockets, are utilized, as on all Westland helicopters, and are claimed to afford immunity to temperature and humidity effects thus remaining in balance and obviating the necessity of constant retracking. They are matched to master blades and

Model of Westland Westminster.



HIGH ALTITUDE OPERATION

During recent high altitude trials the Westland Whirlwind helicopter, powered by the new Alvis Leonides Major Engine, demonstrated landings, take-offs and hoverings from a base in the Austrian Alps 11,600 ft. above sea level with seven people on board. No other helicopter of the same capacity has accomplished this performance.

During another arduous demonstration series the Whirlwind not only clearly showed its ability to operate with full loads under S. African high altitude conditions, but also confirmed its Reliability and Ruggedness during difficult test tasks.

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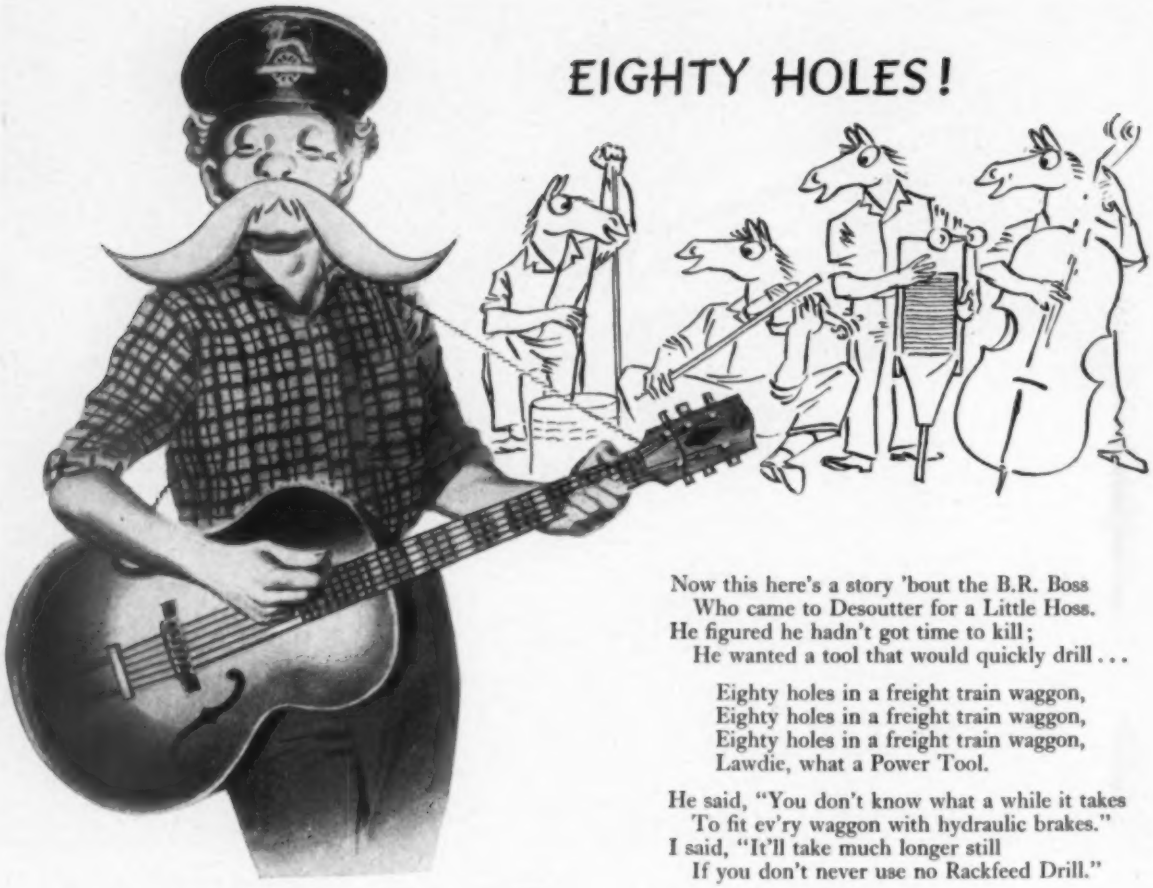
WESTLAND AIRCRAFT LIMITED • YEOVIL • ENGLAND



EIGHTY HOLES!

Now this here's a story 'bout the B.R. Boss
Who came to Desoutter for a Little Hoss.
He figured he hadn't got time to kill;
He wanted a tool that would quickly drill . . .

Eighty holes in a freight train waggon,
Eighty holes in a freight train waggon,
Eighty holes in a freight train waggon,
Lawdie, what a Power Tool.

He said, "You don't know what a while it takes
To fit ev'ry waggon with hydraulic brakes."
I said, "It'll take much longer still
If you don't never use no Rackfeed Drill."

Eighty holes etc.

He went to the East for to give it a test,
Then he tried it for size on the old Great West
An' he said, "By Donegan, sump'n's wrong:
It's a wunnerful drill but it's far too long."

Eighty holes etc.

Now I wasn't gonna lay me down and die,
An' I thought, what the heck, I'll give it a try.
Sure my dentist says it was most unwise,
But I chewed it down to the perfect size.

Eighty holes etc.

Now I reckon I've made it mighty plain,
If our tools ain't right, then we tries again
An' in case you forget, I can only urge
That you sings to yourself this 'orrible dirge . . .

Eighty holes in a freight train waggon,
Eighty holes in a freight train waggon,
Eighty holes in a freight train waggon,
Lawdie, what a Power Tool.

FEATURING

"Skiffle" Desoutter and his Rackfeed Drillers

This shortened version of the Rackfeed Drill, ordered by British Railways and their contractors, has a bayonet nose adjustment which locks on to the jig plate. This guarantees perfect alignment even when an unskilled operator is using the tool.

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CRC 291

Helicopters of the World . . .

have the distinct advantage of individual interchangeability instead of requiring replacement of a complete set of blades if one has become damaged. The blades can be folded backwards to reduce storage space of the helicopter.

● Rotor diam., 53ft; fuselage length, 42ft; weight equipped (Leonides Major), 5,336 lb; gross weight (Leonides Major), 7,800 lb; max. permissible speed, 110 m.p.h.; max. cruising speed (Leonides Major), 99 m.p.h.

Wessex The Wessex has been developed initially for naval use and is powered by a Napier Gazelle free turbine unit. Its naval duties include anti-submarine operation, rescue, communications and casualty evacuation, and a secondary military version will carry fully equipped troops with alternative accommodation for stretchers. For civil use the Wessex will be offered as a 12-seater.

The airframe is of stressed-skin construction and the tail and the fuselage is arranged to fold, thereby saving 8ft of hangar space. The tail rotor driving shaft disengages automatically and folds with the tail unit. Volume of the main cabin is 397 cu ft, and access is by sliding doors—4ft high by 4ft 4in wide—on the starboard side. A hydraulically powered winch hoist is fitted above the cabin door on the starboard side of the helicopter. Loads of 600 lb can be lifted. Control is either by the pilot or the crewman in the cabin.

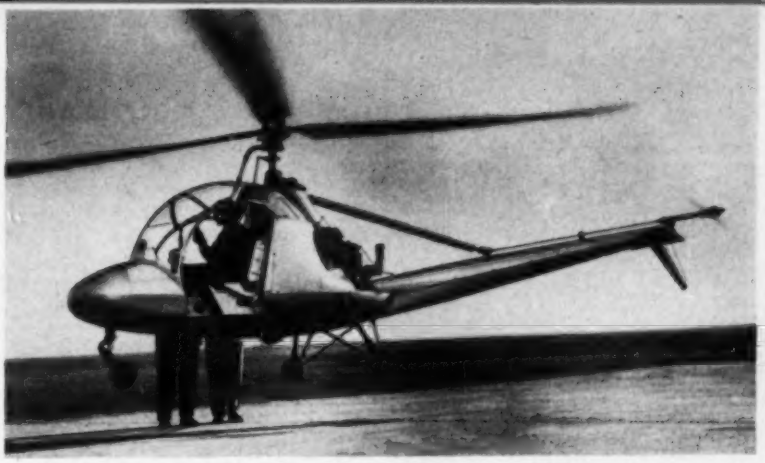
Access to the engine compartment, in the nose, is by downward-hinging doors, as distinct from the conventional horizontal-opening clamshell doors fitted to prototypes. The doors are also service platforms for radio and electrical gear in compartments in front of cockpit. Dual controls are provided and there are two independent high-pressure hydraulic servo systems operating on both the azimuth and collective pitch controls. A spring-loaded stick-centring device neutralizes stick forces for any set flight condition. The rudder (tail rotor) control is also servo-operated.

Standard fuel capacity of both civil and military versions is 300 Imp. gal, disposed in ten crash-proof bag tanks in the belly structure of the fuselage section beneath the cabin floor and one big tank in a forward section of the belly space.

The four all-metal main rotor blades are of similar construction to those of the Whirlwind, retaining the Westland trailing edge "pocket" construction. The rotor hub is of similar design to that proved in the Whirlwind, incorporating flapping and drag hinges with appropriate dampers and swash-plate control mechanism. By folding the blades manually towards the rear the overall length of the machine can be reduced from 57ft 3in (minimum position of rotor) to 38ft 2in.

Because of the free turbine characteristics it has been possible to eliminate the conventional clutch and fan unit thus simplifying the transmission and saving weight. The epicyclic main gear box now has only a single reduction stage which materially contributes to improve strength and mechanical functioning of this unit.

The production version of the Wessex will have a Napier Gazelle NGa.13 engine, having a 1 hr rating of 1,430 s.h.p. and a max. continuous rating of 1,200 s.h.p. As the free-turbine system eliminates all mechanical linkage between the turbo compressor and the rotor drive, the engine can be run, with the rotor braked, under no-load conditions up to ground idling speed. The makers claim that flight trials have proved the Wessex to be the quietest rotary-engined machine so far developed.



Omnipol HC-2 Heli-Baby.

● Rotor diam., 56ft; overall length, 65ft 9in; empty weight (transport), 7,600 lb; gross weight, 12,600 lb; cruising speed, 115 m.p.h.; max. speed, over 132 m.p.h.; hovering endurance, 3 hr; vertical rate of climb at s.l., 600ft/min; max. range, 340 n.m. (standard tankage).

Westminster The first example of this very impressive twin-turbine helicopter (Napier Elands) is a "crane" or utility version, and it is expected that this machine will begin its engine runs about May. The type will later be developed for civil and military transport.

Of Westland design, the Westminster will utilize some components of the Sikorsky S-56. The two Napier Elands have rear drive and because of this feature they are placed well within the fuselage contours, thus, the makers point out, minimizing rotor downwash interference effects and providing a configuration with optimum hovering performance. The makers further state that the use of S-56 components such as the main rotor blades and hub, tail rotor, tail rotor transmission, the epicyclic gearing and other details in the main rotor gearbox—also the duplicated power-operated flying controls—means that full advantage is taken of the lead time gained by these American-designed components. Together with these advantages there are the benefits of testing and proving which the American components have had over a considerable period of operational conditions.

The prototype will be powered by Eland 229 engines of limited power output, but all components of the helicopter, such as the rotor transmission, rotor head, etc., have been designed to accept the power of the more powerful Eland NEl.5 engines which will be available for production helicopters. These engines, it is remarked, will confer a remarkable degree of safety to the operation, since the power of the Eland NEl.5 engine is sufficient for single-engine hovering flight.

The rotor hub is of Sikorsky design. A large offset of the flapping hinge provides a c.g. range of 24in, which permits indiscriminate loading without the usual necessity for ballasting. All-metal main rotor blades with heavy extruded leading-edge spars and honeycomb-filled trailing areas afford freedom from incidental damage and a fatigue life of over 2,000 hr. Provision is made for hot air de-icing of both the main and tail rotor blade assemblies.

The fuselage is of monocoque construction with provision for a normal fuel load of 920 Imp. gal of fuel under the cabin floor. The floor structure is designed to accommodate seat rails and the disposition of large windows permits a variety of seating arrangements.

The simple fixed undercarriage, with low-pressure tyres, is suitable for operating from unprepared ground. At a cruising speed of 150 m.p.h. range performance is not unduly affected and maintenance procedures are materially improved by its being non-retractable.

Provision is made in the transport version for at least 39 passengers.

● Rotor diam., 72ft; overall length, 86ft 9in; empty weight equipped (civil), 20,000 lb; normal gross weight, 33,000 lb; estimated cruising speed, 150 m.p.h.; estimated rate of climb at s.l. (two engines at 66 per cent max. cont. power), over 2,000ft/min; still-air range (full normal fuel), 500 miles.

CZECHOSLOVAKIA

Omnipol, Ltd.

Washingtonova 11, Prague III.

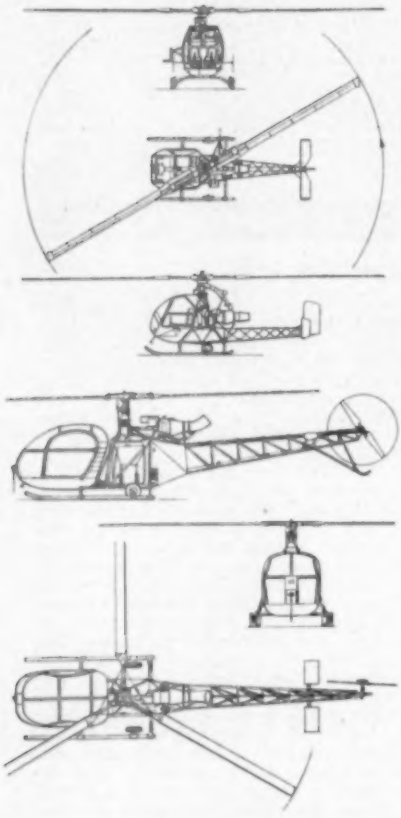
HC-2 Heli-Baby The following is a maker's description of the HC-2 Heli-Baby: "The Heli-Baby is the world's lightest two-seater helicopter with a three-bladed, fully articulated main rotor and dual controls. The powerplant is a flat-four Praga DH developing 83 h.p. at 3,000 r.p.m.

"The Heli-Baby can be used as a trainer, observation post, courier and for a number of other jobs. The following features make it well suited for primary helicopter pilot training: rugged construction, controls with suitable response and sensitivity, satisfactory stability characteristics and low costs per flying hour. Practice engine-off landings can be performed without the necessity of switching off the engine. The Heli-Baby has an extremely low vibration and noise level, and an excellent visibility. Its small overall dimensions and high manœuvrability enable the Heli-Baby to land on and take off from the smallest unprepared sites. As a single-seater, the Heli-Baby can be profitably used for numerous other purposes, such as air-mail service, advertising, agricultural pest control, field intensity surveys, fire patrol, material transportation, snow and ice surveys, etc. Besides the pilot, the Heli-Baby can carry a photographer, reporter, geologist, doctor or any other person needed urgently anywhere.

"In all these operations the Heli-Baby is unsurpassed in economy, as it carries a pilot and a total of 220 lb of payload over a distance of 62 miles in a one-hour flight at a total consumption of 4.85 gal of fuel. Over long distances it can be easily transported on railroad or truck, due to its low weight, small overall dimensions and quickly removable rotor blades. The general layout of the Heli-Baby makes it possible to inspect and service the whole machine from ground level."

● Rotor diam., 28ft 11in; overall length, 34ft 5in; empty weight, 840 lb; gross weight, 1,280 lb; max. level speed, 78 m.p.h.; cruising speed, 62 m.p.h.; range at cruising speed, 93 miles: hovering ceiling (with ground effect), 3,600ft; service ceiling, 10,150ft; rate of climb, 710ft/min.

Left and lower left, SO.1221 Djinn. Right, SO. Gouverneur.



Helicopters of the World . . .

FRANCE

Sud-Aviation, Société Nationale de Constructions Aéronautiques
37, Boulevard de Montmorency, Paris 16e.

SO.1221 Djinn The fuselage of the Djinn is a light framework of steel tubing. The two-seater cockpit is protected by plexiglass panels which give 360 deg visibility. Landing gear consists of two skids fitted with two wheels which, when the helicopter is on the ground, may be retracted and are actuated manually by means of a crank, which is also used for starting up the turbine.

The hub assembly freely oscillates around the spherical thrust bearing, and is flexibly mounted on a pylon of steel tubes by means of a ball joint and rubber shock absorbers. The compressed air supplied to the blades passes through the hub casing, consisting of two spherical faces which turn and oscillate with the hub. The cyclic and collective pitch controls are of the "spider" type and the hub assembly may be easily dismantled.

The all-metal blades consist of an extruded spar of tapering thickness, inside which is channelled the compressed air which is ejected at the blade tips; a trailing edge which is locked on with piano wires and filled with honeycomb; a counterweight located in the fore part of the spar; and an ejection nozzle. The roots of the blades, which are completely faired, increase the lift coefficient. The blades are claimed to offer the following advantages: great homogeneity of structure, with perfect surface finish and constant profile, and easy dismantling which facilitates inspection of the main spar. In addition to these advantages, the blade runs no risk of icing, since a current of air at a temperature of around 160 deg (320 deg F) passes through it.

Flight controls are of standard type, with the throttle on the collective pitch lever; friction trims, adjustable in flight, are included.

Capacity of the normal fuel tanks is 66 U.S. gal. Two auxiliary tanks of a total capacity of 22 U.S. gal may be installed permanently. In addition, for ferry missions a special tank of about 22 U.S. gal may be installed in the place of the passenger. The fuel circuit includes a decanting unit, a filter and a fuel cut-off cock.

The compressed air generator is a Turboméca Palouste IV having an overdimensioned compressor which absorbs the entire turbine power. The great quantity of compressed air produced, which exceeds the amounts necessary for driving the turbine, is ducted through the hub and the blades of the rotor. The residual thrust of the turbine contributes to propulsion, and acting on the rudder, provides for directional control, in the case of hovering.

The Djinn has numerous civil and military applications and certain of the military rôles are of particular interest. For example, tests have recently been carried out to determine possibilities in anti-tank warfare. The combat principle is as follows: the Djinn, carrying a guided missile, hides behind trees, hills, buildings, etc. At the right moment, it rises vertically just above the objective, aims and fires. It is claimed to be extremely difficult for the tank to sight its adversary and to defend itself during the short time of attack. Also in the ground-attack rôle the Djinn can be equipped to carry a machine gun manned from the second seat.

The makers claim that the exceptional manoeuvrability of the Djinn greatly reduces its vulnerability in the A.O.P. rôle, and recent tests, made with a camera gun, are said to have proved that it is more difficult to shoot down a helicopter than a light aeroplane.

● Rotor diam., 36ft 2in; fuselage length, 17ft 4in; empty weight, 794 lb; gross weight (civil), 1,676 lb; gross weight (military), 1,764 lb; disc

Above and below, SO.3130 Alouette II.

Westland WESSEX

The Wessex is the first helicopter in the world to go into production powered by a free-turbine engine. During the first flight of the prototype last year it was airborne for sixty-five minutes. It has now embarked upon an intensive flight test programme.

The free-turbine engine gives the Wessex advantages of supreme economic and operational importance:

It enables the helicopter to be airborne from a cold start within 45 seconds.

It uses the same fuel as jet aircraft, thus eliminating the necessity to store two types of fuel on airfields and aircraft carriers.

It reduces the noise element inherent in piston-engined helicopters to an unobtrusive purr.

It reduces vibration to the minimum, which means less wear on components and greater comfort for passengers and crew.

The compactness and light weight of the engines allow for increased payload.

The Wessex has been ordered for the Royal Navy for anti-submarine duties. It is powered by a single Napier Gazelle free-turbine engine.

WESTLAND

The Hallmark of British Helicopters

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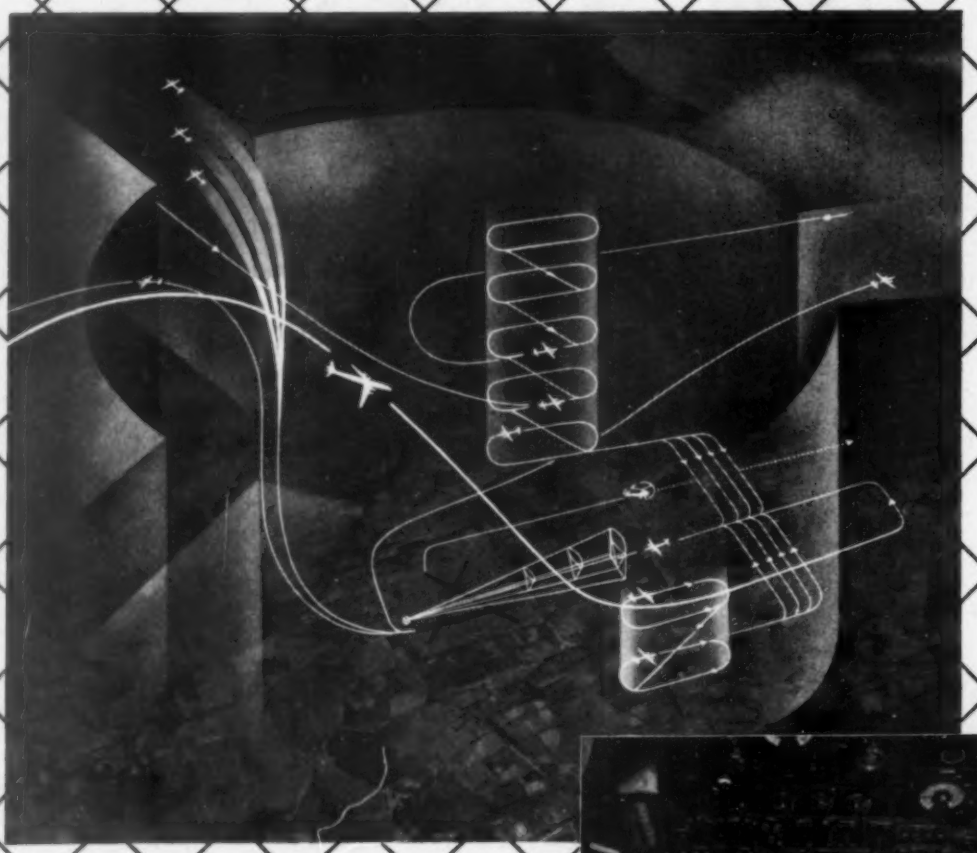

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Decca in the Jet Age

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The accuracy and flexibility of the Decca Navigator, which continuously pin-points the pilots exact position, ensures the efficient working of any traffic pattern, however complex. Holding areas can be designated and flown precisely at any altitude however high. No other aid can do this. Furthermore, no re-positioning of ground facilities is required if airways, terminal area procedures or holding patterns have to be changed for any reason.

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Helicopters of the World...

loading (civil), 1.64 lb/sq ft; disc loading (military), 1.73 lb/sq ft; max. speed, 81 m.p.h.; cruising speed, 62 m.p.h.; max. range (standard tank), 112 miles. N.B. In respect of ceiling it may be noted that the Djinn secured a world record for helicopters of all categories in March last year when it climbed to an altitude of 27,860ft.

SO.3130 Alouette II Since its first flight in March 1955 the Alouette II has established itself as one of the world's leading helicopters and a licence for its construction has been acquired by Republic Aviation. The makers claim that due to its simple design and to its gas turbine powerplant (Turboméca Artouste II) the aircraft can be compared with medium piston-engined helicopters of approximately twice the weight.

The main fuselage structure is of welded steel tubes and is divided into the body, or "working," portion—which supports the main components and carries the transmission platform—and a tail boom. Pilot and co-pilot sit side by side and there is a removable triple seat behind them. The all-metal blades each consist of an extruded light-alloy leading-edge spar, to which is bolted a steel cuff; a light-alloy skin, bonded to the spar, which conforms to the blade airfoil section (aft of the spar the blade is packed with moltoprene filler material); a light-alloy sheet-metal trailing-edge capping strip riveted to the skin; a trim-tab riveted to the trailing-edge capping strip; and balance weights at the outboard end of the blade under a light-alloy tip fairing, retained by screws on the outboard blade rib.

The main rotor-head has a three-armed light-alloy hub, each arm forming a yoke in which a flap-hinge-pin pivots on needle bearings. The other principal components are the blade links; droop restrainers; steel spindles with integral fork ends which pivot on the blade links; steel blade-sleeves mounted on the spindles through needle bearings to permit blade-pitch variation; and a blade-spacing equalizer system consisting of three cables which interconnect the blade sleeves. Each blade folds around one of the two blade-retention taper pins fitted in the outer end of the blade sleeve.

The main transmission comprises three principal components: the main driveshaft and freewheel assembly; main gearbox; and main rotor-shaft unit. Main gearbox reduction ratios are 1:16.32 between main drive shaft and main rotor head, and 1:2.27 between main drive shaft and tail drive shaft. The gearbox itself consists essentially of input bevel gearing and two planetary reduction stages. The input bevel gears at the bottom of the main gearbox are driven by the main drive shaft; they drive the planetary reduction gears through which engine power is transmitted to the main rotor-shaft unit, and the main gearbox oil pump and the tail rotor drive. The main rotor shaft comprises a hollow shaft, splined at both ends, and a flared housing which attaches directly on the top face of the main gearbox.

When *Flight* contributor Basil Arkell flew the Alouette II last summer he reported very favourably, and in respect of handling he wrote: "The outstanding feature of the Alouette II is the turbine speed governor, which controls the flow of fuel to the combustion chamber and so obviates the necessity for a twist-grip throttle on the collective-pitch lever. This greatly reduces the pilot's control co-ordination problems and relieves him completely of the necessity to maintain a constant watch on the rotor r.p.m. indicator during flight.

"The turbine and governor control levers are located on the floor of the cockpit between the two pilots' seats. After 'winding up' the turbine with the electric starter—which, incidentally, also serves as a generator—the fuel cock is opened to introduce kerosine into the combustion chamber. The fuel is ignited by means of a switch on the control panel and the turbine begins to build up speed. The rotor starts to revolve smoothly as the turbine increases speed until, at a little over 10,000 r.p.m., it is fully engaged. The governor control lever is then brought into action to increase the r.p.m. to the normal operating setting. It functions in much the same way as a conventional engine throttle but it is, in fact, shifting the fuel metering datum in the governor mechanism. After the required rotor speed has been attained the lever can be ignored, though its setting can be adjusted to vary the amount of maximum power required by different operating conditions.

"When the collective-pitch lever is raised the governor automatically increases the rate of fuel flow into the combustion chamber in accordance with the demands of the increased pitch setting and in relation to the selected operating r.p.m. If, at the high end of the collective-pitch range, the pilot increases collective pitch too much, and thus demands a greater fuel flow than is available, a prominent red light flashes on the instrument panel to indicate '*limite-puissance*.' He must then lower the collective-pitch lever slightly until the warning light goes out, or he will be over-pitching the rotor and losing r.p.m. In hovering flight or vertical climb the light flashes at a collective-pitch setting of approximately 13 deg; but in forward flight, owing to the greater induced flow through the rotor, a pitch setting of nearly 16 deg may be reached.

"One considerable advantage of the turbine engine is that no warm-up period is necessary before take-off. Once the turbine is up to speed, which is only a matter of a few seconds, the full power is available and the helicopter is ready to go. Other advantages include ease of maintenance and the fact that the absence of clutch makes the transmission system much simpler."

● Rotor diam., 33ft 6in; overall length (blades folded), 31ft 10in; gross weight, 3,300 lb; empty weight, 1,870 lb; max. speed at s.l., 111 m.p.h.; cruising speed at s.l., 107 m.p.h.; service ceiling, 13,800ft; hovering ceiling with ground effect, 10,200ft; hovering ceiling without ground effect, 7,900ft; range at s.l. (at cruising speed), 330 miles.

Gouverneur The Gouverneur is a very elegant (thoroughly faired and cleaned up) version of the Alouette II, carrying three passengers and a pilot at a speed of 120 m.p.h. over distances of about 300 miles. External characteristics are seen in the photograph on page 376.

Alouette SE.3140 This development of the Alouette has a 400-h.p. Turboméca Turmo II free-turbine unit and is an experimental model ordered by the French Air Ministry. Jump take-offs are made entirely possible by the free-turbine feature.

Bodo Franke Frankocopter.

GERMANY

Borgward-Focke

Kolibri I The first helicopter to be designed and built in the Federal Republic since the war, the Kolibri I has been designed by the helicopter pioneer Dr. Heinrich Focke and is being financed by the Borgward car company. The first example—built in Bremen—should fly within a few weeks. Powered with a Lycoming VO-435A1A piston engine, the new helicopter will be a three-seater capable of cruising at about 100 m.p.h. and should sell at a price between DM.150,000 and DM.200,000.

New Project A larger helicopter is being studied by Borgward-Focke, and it has been suggested that this will be a 40-passenger machine suitable for military or civil operation.

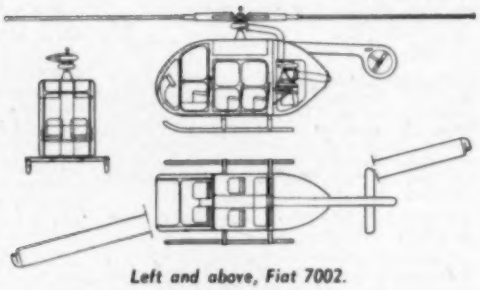
Bodo Franke

Frankocopter The foregoing is the name of the new coaxial-rotor light helicopter built by Bodo Franke of Cologne and illustrated on this page. A three-seater, it has a 105-h.p. engine and is expected to sell for DM.65,000 (£5,500).

HUNGARY

The Mechanical Laboratory

Prototype Helicopter The first prototype of a new helicopter is being built in the No. 2 workshop of the Mechanical Laboratory at Budapest. Flying trials are scheduled for this summer. A cruising speed of 80 m.p.h. is mentioned, together with a rate of climb of 400ft/min and a ceiling of 10,000ft. The aircraft is described by a Hungarian source in these terms: "The machine has two substantial differences with other makes, says the newspaper *Nepszabadsag*. It is fitted with rotary weights on a gyroscope principle which keep the machine stable during flight. The steering is said to be extremely sensitive, enabling the pilot to 'physically sense any diversions from course.' Idea of building helicopters was first mooted in 1953 when aeroplanes began to be used for agricultural purposes, such as spraying. Operating costs were found to be high and the planes travelled too fast to be completely satisfactory. The newspaper says the helicopters will be used for health, postal and transport purposes 'and could also be used when constructing high buildings and chimneys and for the aerial inspection of road traffic'."



Left and above, Fiat 7002.

Helicopters of the World . . .

ITALY

Costruzioni Aeronautiche Giovanni Agusta

Cascina Costa, Gallarate.

Agusta-Bell 47 Since 1952 this Italian company has held European manufacturing rights for various versions of the Bell Model 47, and since 1955 has delivered considerable quantities of Model 47Gs and G-2s. The latest product is the 47J Ranger.

All these types are dealt with under the heading of the parent company.

Societa Per Azioni Fiat

Corso Giovanni Agnelli 200, Turin.

Fiat 7002 The Fiat 7002 medium-size, general-purpose helicopter promises to give a ratio of empty weight to useful load of 1:1.33. The main rotor is driven by compressed-air jets at the blade tips, supplied from a specially developed turbo-generator.

This type of "cold jet" propulsion was chosen by Fiat on the grounds of lightness, constructional simplicity, low initial cost, high reliability, long overhaul life, and low maintenance and operating costs. The compressed air is supplied by a Fiat 4700 turbo-generator in which the turbine-driven air compressor is operated by a primary hot-gas generator based on the Fiat 4002 turbojet. The air compressor and the primary engine are mechanically independent, resulting in free-turbine advantages and permitting the optimum compression ratio for the best pneumatic transmission efficiency to be selected. The absence of reaction torque would have allowed the abolition of the tail rotor, since directional control could be obtained by means of a rudder. In order to ensure complete manœuvrability at low forward speeds and in vertical autorotation, however, a small ducted tail rotor, mechanically driven by the main rotor, is employed.

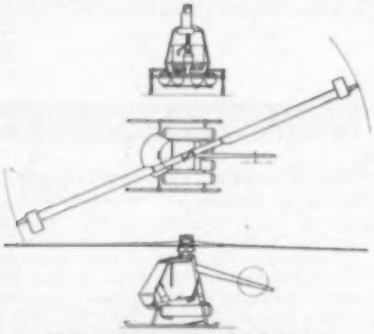
In general construction as well as in structure the machine is based on the concept of flexibility for a number of military and civil applications. The two main-rotor blades have leading edges and spars made from stainless steel welded sheets and incorporating air ducts to the tips. The rotor hub is of the tilting type, the blades being connected by steel strips which bear centrifugal loads and permit blade-pitch variations.

Constructed from light-alloy sheet, the fuselage consists of three main sections which house respectively the cockpit, the main cabin, and the vertically mounted powerplant. A short tail beam carries the ducted tail rotor and a tailplane. The upper portion of the fuselage centre-section embodies the attachments of the main rotor hub, and the fuel tanks. The landing gear is of the skid type.

Normal loads envisaged for the 7002 are (1) one pilot and six passengers, (2) one pilot, one assistant and two stretchers (two additional stretcher litters can be mounted externally), and (3) one pilot and 90 cu ft of freight. Adaptation for other specialized purposes such as rescue or agricultural work is possible, and full dual control is fitted.

Specially developed for use in a cold-jet drive helicopter, the 4700 compressed-air generator is of the free-turbine type, having a prime mover consisting of compressor, combustor and turbine which generates gas to be fed to an independent power turbine. This latter turbine drives the power air compressor. Vertical mounting of the engine reduces the length of the compressed-air duct.

● Rotor diam., 39.4ft; fuselage length, 20.1ft; empty weight, 1,320 lb; normal gross weight, 3,085 lb; cruising speed (est.), 84 m.p.h.; service ceiling (est.), 11,150ft; range (est.), 190 miles.



Above and below, NHI H-3 Kolibrie.

Lualdi

L-55 This new Italian light helicopter incorporates certain Hiller features but is largely of original design. A two-seater, it is powered with a Lycoming O-360 engine of 180 h.p.

● Rotor diam., 32.8ft; gross weight, 2,200 lb; max. speed, 94 m.p.h.; endurance, 3 hr.

NETHERLANDS

Nederlandse Helicopter Industrie N.V.

Vliegveld Zestienhoven, Rotterdam, W.2.

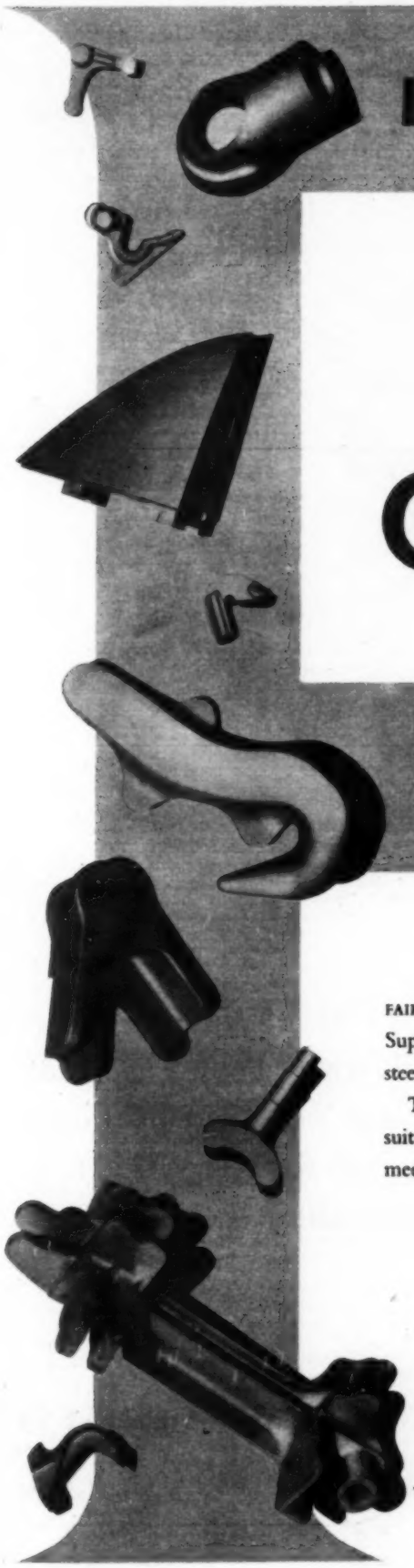
NHI H-3 Kolibrie The NHI Kolibrie (humming-bird) ramjet helicopter is now coming off the production line after some 2½ years and 500 hr of flight testing. The NHI ramjets have also passed the 150-hr type test of the Rijksluchtvaartdienst (Civil Aviation Board) which covers the U.S. and British requirements. Like the Friendship, the Kolibrie is a national effort. Design and development were carried out with the help of the Netherlands Aircraft Development Board (NIV) at Delft and the National Aeronautical Research Centre (NLL) at Amsterdam; while the manufacture is divided between Aviolanda (airframe), Kromhout (ramjets and rotor head) and Fokker (Redux-bonded metal rotor blades).

The rotor design is simple and unusual, allowing a direct hanging-stick control without dampers. A see-saw hinge is used, with a leaf-spring blade root replacing flapping hinges and torsional bearings. The blade cg has been kept ahead of the lift centre so that the rotor is self-adjusting and the aircraft is highly stable. Further unconventional features are the over-size rotor and almost twin-engine safety. Because the rotor is 300 per cent "oversize" it stores sufficient kinetic energy to eliminate the unsafe hovering altitude. It is claimed that ten seconds are available in which to change to autorotation, while eye-witnesses report that it is possible to land—then take off again to ten feet without engines. Out-of-balance loads with one engine stopped are so small in relation to the rotor inertia that the Kolibrie can be brought in on one engine. The kinetic energy in the rotor can further be used, on the "jump-start" principle, to give a brief emergency climb rate of 2,000ft/min.

Designed principally for agricultural work, the Kolibrie's ramjets burn domestic paraffin, thus greatly reducing fuel costs and offsetting high consumption. The airframe is brief indeed, being no more than a connecting link between rotor, crew and the four standard tanks that can be filled with fuel or spray liquid. The single-bladed tail rotor is for directional control only and, should it stop, full pedal movement operates a trim rudder which will keep the helicopter straight against rotor-bearing friction at full power.

● Rotor diam., 33ft; length, 13ft 10in; empty weight, 530 lb; gross weight (civil), 1,435 lb; gross weight (military), 1,545 lb; max. speed, 70 m.p.h.; max. cruising speed, 60 m.p.h.; rate of climb at 30 m.p.h., 1,200ft/min; endurance (pilot only), 1 hr.

(This review is continued on page 389, after special features in photogravure section.)



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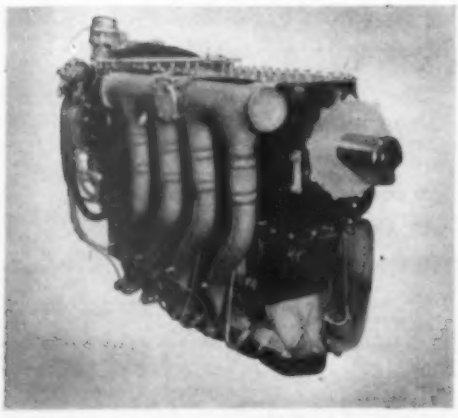

Saunders-Roe Skeeter helicopters now being built for the West German armed forces are powered by Gipsy Major 215 engines for long life, reliability and outstanding fuel economy.

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U.S. Marine Sikorsky HRS helicopters return in formation to their base at Oppaman, Japan.

Who Believes in Helicopters?

By JOHN W. R. TAYLOR

"About four weeks ago, Northeast Airlines filed with the Civil Aeronautics Board an application to open helicopter lines to augment present air-mail operations in six New England states and New York. Later on, the company hopes to set up helicopter passenger schedules . . . ."

LEST New York Airways be alarmed at the prospect of such large-scale competition, it may be as well to point out that the above news item appeared in *Collier's* magazine nearly 15 years ago, when the Press in America first recognized the development potential of Igor Sikorsky's pioneer VS-300 helicopter. Northeast Airlines, no doubt, lost much of their enthusiasm after studying the operating costs of production types.

In this they are not alone. As recently as July 1954 Mr. Peter Masefield, then chief executive of B.E.A., told readers of *The Sunday Times* that by 1958 there should be "30-passenger twin-engine helicopters beginning to fly between London and Paris, Amsterdam, Brussels, Manchester and Birmingham at 110 m.p.h." His predicted time-scale shows every sign of being optimistic by about 100 per cent, and he has since felt compelled to comment that "the available helicopters resemble a pretty girl—they are small, nice to look at and to be seen about with, exciting, pleasant to take out, apt to be noisy; and the more you have to do with them the more expensive they get and the more problems they bring around your neck."

Even the military helicopter seems to have fallen well behind schedule, because the U.S. Army still has far too few to replace trucks completely for work in forward battle areas, although this was reported to be its plan after the Korean War.

It is easy, therefore, to feel depressed and disappointed with helicopter progress, without realizing that much of the blame must be laid on those journalists and enthusiasts who expected too much too quickly. If we start to unearth the facts, it becomes apparent that in its short career the helicopter has really done quite well.

Unlike the fixed-wing aeroplane, it has achieved its most spectacular successes on missions to save life rather than to destroy it. Helicopters in Korea evacuated more than 22,000 casualties from front-line positions and helped to reduce to an all-time low the percentage of men who died from their wounds. This was no isolated operation in unique circumstances, for rotating-wing aircraft have kept up comparable good work ever since. Sometimes a single critically injured person has been snatched from death high on a mountainside, deep in the jungle, or from a ledge on a tall building. Sometimes ten or twenty have been lifted from a sinking ship. Occasionally hundreds have been hauled to safety in a day or two, as when Hurricane Diane flooded Connecticut in August 1955 and caused the greatest disaster in the history of that State.

These are examples of work that only a helicopter can do; no other vehicle shares its ability to go virtually anywhere, regardless of terrain, and to lift a person or object from the ground whilst hovering when there is not even a toehold for its multiphibious landing gear.

There are other jobs that a helicopter can do more quickly, or more economically, than conventional vehicles. It can spray crops with insecticide without (as ground implements may do) trampling down a proportion of the plants, destroy a swarm of locusts speedily enough to save a primitive village from starvation, lift a radar scanner to the top of a tower when no other suitable tackle is available, or hoist materials for a dam on some inaccessible site.

Such achievements are fine and worthwhile. But how often are men injured on tall buildings? How many radar scanners cannot be put in place by ordinary lifting gear? How many dams are built in areas without roads or railways?

In short, the exploits that have earned the greatest publicity are seldom of the type that would keep a large fleet of aircraft busy on a year-round basis. On the other hand, they are far from negligible, because some 400 helicopters are employed on charter work by about 80 companies in the United States alone. But operations of this kind will never be sufficient to keep the manufacturers in business, and there will be no real future for the helicopter unless it first enters service on a much wider scale with the armed forces and airlines. These are the only customers who can afford to underwrite high development-costs, and their comparatively small investment and interest in helicopters at the present time is the most ominous portent for the future.

The Westland Widgeon (left) now has a full C. of A. for operation on pontoons. (Right) Fison-Airwork Hiller banana-spraying in Jamaica.

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Communications afloat: A Bristol Sycamore brings an officer to H.M.A.S. "Arunta."

Lifeguard patrol: Hauling exhausted swimmers from the sea is routine work for the helicopters of New York's Police Department. The Bell 47C is passing Coney Island Beach.

Technical and Financial Problems.—Such an attitude is understandable, because—let us face it— the helicopter of today leaves much to be desired. It is too small for most transport jobs, too costly to buy and to operate, too noisy, too complex and with too low a fatigue life for easy maintenance, too difficult to fly and too slow in developing into an all-weather aircraft.

Before considering the possible future growth of helicopter operations it is as well to try and discover how the manufacturers are tackling these problems, because if they are not solved there may be no future.

Some designers believe that use of tip-driven rotors will eliminate the majority of the helicopter's present troubles. Absence of complicated, costly-to-machine transmission systems should certainly cut production costs and servicing, and dispense with some of the components that are most prone to fatigue. But in exchange there are such difficulties as ensuring efficient air and fuel supply to the rotor-tip units and of keeping their noise-level within reasonable bounds.

There is little doubt that, in time, tip-drive could and should be extremely efficient for all shapes and sizes of helicopter; but are potential operators prepared to wait, and who is to pay for the lengthy development process? These questions are of particular significance in Britain; for if B.E.A. are to open their long-awaited network of scheduled helicopter services in the mid-sixties they will have to make their choice of either the shaft-driven Westland Westminster or the tip-driven Fairey Rotodyne within the next two years.

Both aircraft are of much the same size, the Westminster carrying 39 passengers and the Rotodyne 40-48; and both are powered by two 3,500 h.p. Napier Eland turbines. The Rotodyne is more advanced in concept, with a higher performance. The Westminster should require a shorter development period; because its main rotor hub and blades, upper epicyclic reduction-gear sections, tail rotor transmission, tail rotor, and hydraulic power controls are those of the Sikorsky S-56 and will have the experience of 70,000 flying hours built into them from the start.

It is not easy to obtain civil certification for a rotor and transmission system, and Westland believe it is unwise to discard a well-proven system in favour of a completely new type that promises advantages on paper. This policy of playing safe has so far paid dividends. The company's production of 138 Dragonflies and over 200 Whirlwinds—both of Sikorsky design—has made them the leading helicopter manufacturers in Europe; and their reputation will be enhanced by the turbine-powered Wessex (basically a Sikorsky S-58) which is now under development in both military and 12-passenger civil versions.

Nor is it inevitable that a shaft-drive transmission system should have a short overhaul-life. By careful redesign, Hiller have increased the life of the transmission system of their Model 360 from 400 hours to 1,000 hours on the latest H-23D version, and at the same time have reduced its weight by 25 per cent and made it capable of absorbing 40 per cent more power.

There is no reason to believe, therefore, that the tip-driven helicopter will supersede the shaft-driven kind quickly or completely; but if the Rotodyne lives up to its promise it will be far more than just another helicopter. With its ability to take off and land vertically, and to cruise at 170 m.p.h. with its rotor autorotating, it could revolutionize travel over ranges up to at least 350 miles.

It is too early to say that success is assured, although flight trials have gone well so far, with no hint of any unexpected major problems of the type that have dogged most other large helicopters in Britain and America. Faireys have also made great progress in reducing the noise of the tip pressure-jets, to the extent that an eventual noise-level of 95 decibels at 200ft is foreseen. There is little point in trying for further reduction, as the great 90-ft rotor itself produces almost as much noise as this when it turns.

Helicopters have played an important part in the construction of the Kemano-Kitimat hydro-electric scheme operated by the Aluminium Company of Canada. This Bell 47D-1 was on charter from Okanagan Helicopters, Ltd.

As for economics, Fairey's helicopter chief designer, Dr. G. S. Hislop, claims that the Rotodyne will offer an operating cost of 3d per seat nautical mile at optimum stage distances, which is at least as good as the modern short-haul fixed-wing aircraft over the same stages and about one-fifth of the operating cost of current helicopters.

The fact that it "converts" into virtually a fixed-wing aircraft for cruising flight means also that the Rotodyne should be able to operate in much the same conditions and under the same flight rules, by day or night, as a conventional airliner. In time, it should do considerably better than this, because a helicopter can grope its way in dirty weather and hover in emergencies, and this should enable it to operate when fixed-wing transports are grounded, once adequate flying and navigation aids are available.

The most concentrated attack on the all-weather flying problem has probably been made by Bell under their IMHEP (Ideal Man Helicopter Engineering Project) and ANIP (Army-Navy Instrument Program) contracts. In brief, these aim at reducing the load on the pilot by providing the helicopter with some kind of auto-stabilization system and by presenting all the flight data needed by the pilot on a flat TV screen display.

Considerable work on such displays for fixed-wing aircraft has been done by Douglas in America and by the Smiths group in Britain. Bell visualize their ultimate helicopter instrumentation as a two-panel system. On a flat screen in front of the pilot will be a contact analogue display, made up of moving grid patterns indicating altitude, speed, turns and other manœuvres. Below will be a more or less horizontal navigation display in the form of a map on which the pilot will see his position, track, time-to-destination and maximum range. He will need only to index the display at the beginning of a flight, select his destination and then navigate entirely by the display.

ANIP has already reached the stage where major portions of the data system are being tested in a full-size flight simulator, consisting of a standard helicopter cabin mounted atop a dynamic platform that can reproduce pitch, yaw, roll and heave. Bell believe, on results so far achieved, that it will not be long before average pilots will be able to operate helicopters by day or night in all but the most severe weather, using such instrumentation.

Although of a less sophisticated nature, a great deal of useful development work in all-weather flying has been done in Britain by the Army/R.A.F. Joint Experimental Helicopter Unit (JEHU), formed at Middle Wallop three years ago. Its terms of reference cover almost every aspect of military helicopter operations, and a variety of studies is conducted simultaneously by groups of three or four men.

Two such teams, equipped with Sycamores and Whirlwinds, have been engaged on research into instrument and night-flying techniques, with equipment such as the Decca Navigator, the radio compass, and Rebecca, Elliott and Burndept Talbie homing aids. Experimental instrumentation tested by the unit has included an artificial horizon with an adjustable datum, an instantaneously recording vertical-speed indicator, an A.S.I. that gives accurate readings at very low forward speeds, a rotary-disc attitude indicator and a radio altimeter that gives positive and accurate readings at all times and at all speeds down to zero.

Instrument flying is done by JEHU under simulated conditions with dual control; but it has been thorough, with cross-country flights of 60 miles and more, involving progressively more difficult flight patterns, autorotations and autorotation recoveries, and G.C.A. and QGH approaches. As a result, the unit hopes to establish techniques of all-weather navigation and homing that will enable the average military pilot to put down his helicopter within a pinpoint area 30ft square.

So there seems no reason why most of the helicopter's technical

Helicopters can operate from small platforms on almost any type of naval or merchant ship.

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and operational problems should not have been solved within the next few years: but there will remain financial problems, and in the end these may prove the more formidable.

All helicopters in current use on scheduled passenger services were produced originally for military duties, which means that the vast majority of all helicopter development costs have been paid out of public funds. Today, with defence expenditure reaching unprecedented sums, the British armed Services are putting first things first in face of growing public criticism. Nuclear weapons—and aircraft, ships and missiles to carry them—are taking precedence over all else, including helicopters.

Similarly, most major airlines are committed to spending far more money than they can really afford on new jet and turboprop transports to "keep up with the Joneses." Why should they voluntarily throw away money by operating tiresome local services with current helicopters that are completely uneconomical? And how can they find cash to contribute towards the development of more advanced helicopters that might work in 1965?

The exceptions are the Soviet armed forces and Aeroflot, for whom financial considerations are less critical, and the results are clear. At a time when there is not a single fully-developed 40-seat helicopter flying in the West there are dozens of Yak-24s in service with the Soviet forces; and the 80-seat twin-turbine Mi-6 has reached the stage where it has set up international load-carrying records before any comparable Western helicopter is off (perhaps even on) the drawing boards.

Just how serious this might be, at a time when our aircraft industries are beginning to feel the loss of military orders, can be gauged from a quick survey of the part helicopters could play in military and civil aviation if given the chance.

Two Kinds of War.—According to Britain's Defence Minister, the R.A.F.—in common with our other Services—is being reshaped for maximum effectiveness in preventing big wars and fighting little ones; but a study of successive White Papers and Estimates gives little reassurance that this will be achieved.

The deterrent forces are there right enough—Valiants with A-bombs and H-bombs in service; Vulcans and Victors with "stand-off" bombs on the way; Thor IRBMs by the end of 1958, minus U.S. warheads; and, presumably, plenty of British warheads for our own forthcoming superior IRBMs.

If we continue to think for a moment in terms of total war, these formidable masterpieces of misguided progress are probably adequate for the United Kingdom. But they are defensive weapons, valuable only while they are able to prevent war. If their deterrent powers fail, they become a David advancing to do combat with a Goliath clever enough to have his own sling and five times five smooth stones. There is little point in our planning what we should do next after both sides have used up their nuclear weapons.

This may sound defeatist; but events of the past 13 years have shown that local wars and "police actions" are not only more likely than global wars, but almost inevitable. So it is realistic to plan energetically for such campaigns and to waste little thought on what would follow the failure of our first-priority deterrents. In any case, a "broken-back" post-nuclear-phase global war would probably demand much the same equipment and tactics as a local non-nuclear war, only on a larger scale. Both offer ample scope for the effective use of helicopters in a variety of rôles.

First essential is to get ground forces as quickly as possible to where they are needed, and Suez showed how lamentably

Firing an S.S.10 anti-tank missile from an S.O.1221 Djinn.

equipped the British services are to achieve this. Twenty Britannias and a few squadrons of Beverleys will form a small basis for the vitally-needed air transport and re-supply service; but there is little indication that the Defence Ministry yet understands the necessity of a high degree of mobility in all aspects of modern warfare.

Back in 1956 the U.S. Army gave details of what it called its Pentana concept—a plan for the integration of all modern forms of weapon (including missiles) with transport aircraft, for maximum efficiency in any type of war. "Pentana" signified simply a five-sided organizational structure (PENT) and a merged capacity for atomic/non-atomic operations (ANA).

Explaining the concept, the Army's annual Report commented:—

"To fight successfully on the battlefield of the future, the Army must no longer be roadbound and tied to a ponderous logistical tail. Rather it must develop improved cross-country mobility with lightly armoured personnel and cargo-carriers, plus increased use of air vehicles. Transport of units into the battle area and back and forth within the battle area must be accomplished in large part by aircraft. Much of the supply to and within the field army must be delivered by aircraft of the assault cargo and convertiplane type.

"The increased mobility of a Pentana division comes largely from the leanness of its basic structure. Much equipment and some units have been removed and pooled at higher command levels. This stripping leaves the airborne division and battle groups of the infantry division light and completely air-transportable. Units will be able to disperse quickly to avoid detection and converge to fight.

"Pentana provides for extensive use of atomic firepower. An ever-increasing range of sizes and yields permits the firing of atomic warheads in most of the Army's missiles and some of its cannon. The atomic-bearing missile gives a commander almost unlimited flexibility and crushing firepower. His longer-range missiles have the capacity of supporting his far-flung and fast-ranging battlegroups over the vast distances of the atomic battlefield. This combination of range, accuracy and punch permits him to mass his firepower without necessarily massing his forces."

For non-atomic warfare, "Pentana visualizes greatly increased firepower. Remarkable progress has been made in the design of high-explosive warheads for smaller missiles and conventional weapons." And to ensure the all-important good communications on the ground, new lightweight, long-range, reliable equipment is being produced, including small radios built into the helmets

(Left) A Sikorsky H-37 lifts a two-and-a-half-ton truck. (Right) A Kaman HOK-1, carrying a pilot and three fire-fighting rescue crewmen, hovers while the fire-fighting equipment is attached to the helicopter's external cargo hook. The equipment consists of two Ansul 300-lb dry chemical tanks, each with 100ft of hose, and rescue tools.

The Alvis Leonides Major engine powers the new Westland Whirlwind Helicopters now in service with the Royal Navy. The Leonides Major gives the Whirlwind a 30% increase in rate of climb and 100% greater ceiling.

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On August 28, 1957, at U.S. Naval Air Test Center, Patuxent River, Maryland, in the presence of Mr. Gates, Secretary of United States Navy, Admiral Thurstan Clark, U.S.N., Commander Naval Test Center and many U.S. Navy Officials, Flying Officer S. Hughes, R.A.F., ejected at runway level from a Grumman Cougar taking off. This ejection, the first from ground level in America, was done to demonstrate the Martin-Baker Patent Fully Automatic Ejection Seat at present being supplied for U.S. Navy aircraft. The upper photograph shows the main parachute streaming. On the right, Hughes, immediately after the ejection, is being congratulated by the designer of the seat, Mr. James Martin, C.B.E. Design features of this seat are patented in U.S.A. and Great Britain.

Martin-Baker

AIRCRAFT COMPANY LIMITED, ENGLAND & CANADA

No tools are needed to assemble the Hiller XROE-1 one-man helicopter, and the operation takes only ten minutes. The photograph on the right suggests this lightweight's dragonfly-like qualities.

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of individual soldiers and television cameras in aircraft and pilotless reconnaissance drones, including helicopters.

Nor is Pentana merely an idea, because the U.S. Army's 101st Airborne Division has already been converted into a lightweight, hard-hitting, completely air-transportable force with 6,000 fewer men than in a conventional airborne division. With its equipment, it can be carried in roughly half the aircraft previously needed. Quoting again from the Report:—

"In line with the Pentana concept, the basic combat organization of the 101st is built on five combat groups somewhat larger than present battalions but smaller than present regiments. Each group contains five rifle companies and its own artillery mortar battery as well as the usual headquarters and service companies. Its divisional artillery contains five 105-mm. howitzer batteries and an 'Honest John' rocket battery.

"In support of the basic combat units is an Engineer battalion, one of whose important missions is the improvement of areas to permit the landing of assault aircraft such as the C-123. Logistical support is centralized in a single support group.

"To provide the additional communcations required to support this mobile division, a signal battalion has replaced the normal signal company. The 101st also has a unique organization known as the Command and Control battalion, which contains not only the divisional headquarters company but also an aviation company and a reconnaissance troop, both of which contain aircraft."

Other U.S. airborne divisions may soon be reorganized on similar lines. On the other hand, any new infantry division will be organized with primary emphasis on its capabilty for sustained ground combat, as opposed to air transportability, so that it will have heavier fire support than the airborne divisions, plus tanks and armoured personnel carriers.

Although this Report refers only to "convertiplanes," it is easy to see how many different types of helicopter would fit into the Pentana concept. Large, comparatively fast machines of the Rotodyne type would be ideal assault transports, providing complete battlefield mobility and, as at Suez, a convenient means of landing troops from carriers steaming offshore and of evacuating casualties for speedy treatment on the return shuttle.

Far too little has been published about the achievements of the British helicopter units (consisting of JEHU and 845 Naval Squadron) at Suez—probably because of the lamentable ending

Helicopters perform valuable duties for oil-drilling enterprises. Seen beyond this exploration rig is a Doman LZ-5 used for carrying equipment.

This Bell 47G-2 served with Commandant I. Petitjean's French IGY team in Antarctica.

Soviet scientists have made considerable use of Mi-4 helicopters for purposes of polar exploration and research.

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of the affair. So it is worth recording here that 415 men and 24 tons of stores were ferried over the nine miles from ship to shore in 2 hr 20 min, during which just on 100 casualties were brought back to the parent ships by JEHU aircraft alone. This unit's Sycamores were able to land-on and take off again within 90 sec, and required only an extra 90 sec for refuelling.

Medium-size helicopters like the Whirlwind, and the later Sikorsky S-58 or Wessex, are probably large enough for work in the actual front line. Their duties under a Pentana concept would involve ferrying individual companies to tactical positions, hauling guns, rocket launchers and supplies quickly over any terrain, independently of roads and bridges, and perhaps even taking a hand in the fighting.

Under the code-name of "Skycav" (Sky cavalry), the U.S. Army has been experimenting for some time at its Aviation Center, Fort Rucker, Alabama, with the use of helicopters for close support of ground forces, and the results are fairly promising. The idea is not to send helicopters ranging into enemy territory in the manner of fighter-bombers, but purely to support local groups of men, perhaps even the ones they have ferried to the front line. They can carry a surprisingly effective armament. A small Bell H-13 or Hiller H-23, for example, can have four machine-guns and sixteen 3.5in rockets slung on the crossbars of its skid landing gear. A Sikorsky H-34 (S-58) has been equipped experimentally with forty 2.75in rockets, two 5in anti-tank rockets, two 20 mm cannon and nine machine-guns all at once.

Nor would helicopters necessarily be too vulnerable for such work. Very few were destroyed by enemy fire in Korea, where they were seldom far from the front line; and their unique flying characteristics would enable them to fly below enemy radar beams and to take advantage of every scrap of cover offered by trees and hills.

Finally, there must be ever-wider use of light helicopters for observation, liaison, casualty evacuation and similar duties, for even the rugged Jeep is no longer versatile enough for Pentana type operations. Surface vehicles are out—not in a half-hearted manner, but almost entirely—and that goes even for motor cycles. Why else would the U.S. Services be concentrating so much effort on developing one-man helicopters and "flying platforms"?

The Hiller XROE-1 Rotorcycle is a superb example of an aircraft that would give one soldier complete 52 m.p.h. mobility. Weighing only 270 lb, it can be air-dropped as a tiny package, assembled by one man in ten minutes by simple pin fixings, and flown by a person of average intelligence after very little instruction. The Rotor-Craft Pinwheel is even lighter in weight, and faster, its rotor-tip rocket units giving a cruising speed of 60-70 m.p.h. It is very much quieter than one would expect from a rocket aircraft and has been flown by soldiers with no previous pilot experience after only five hours' instruction.

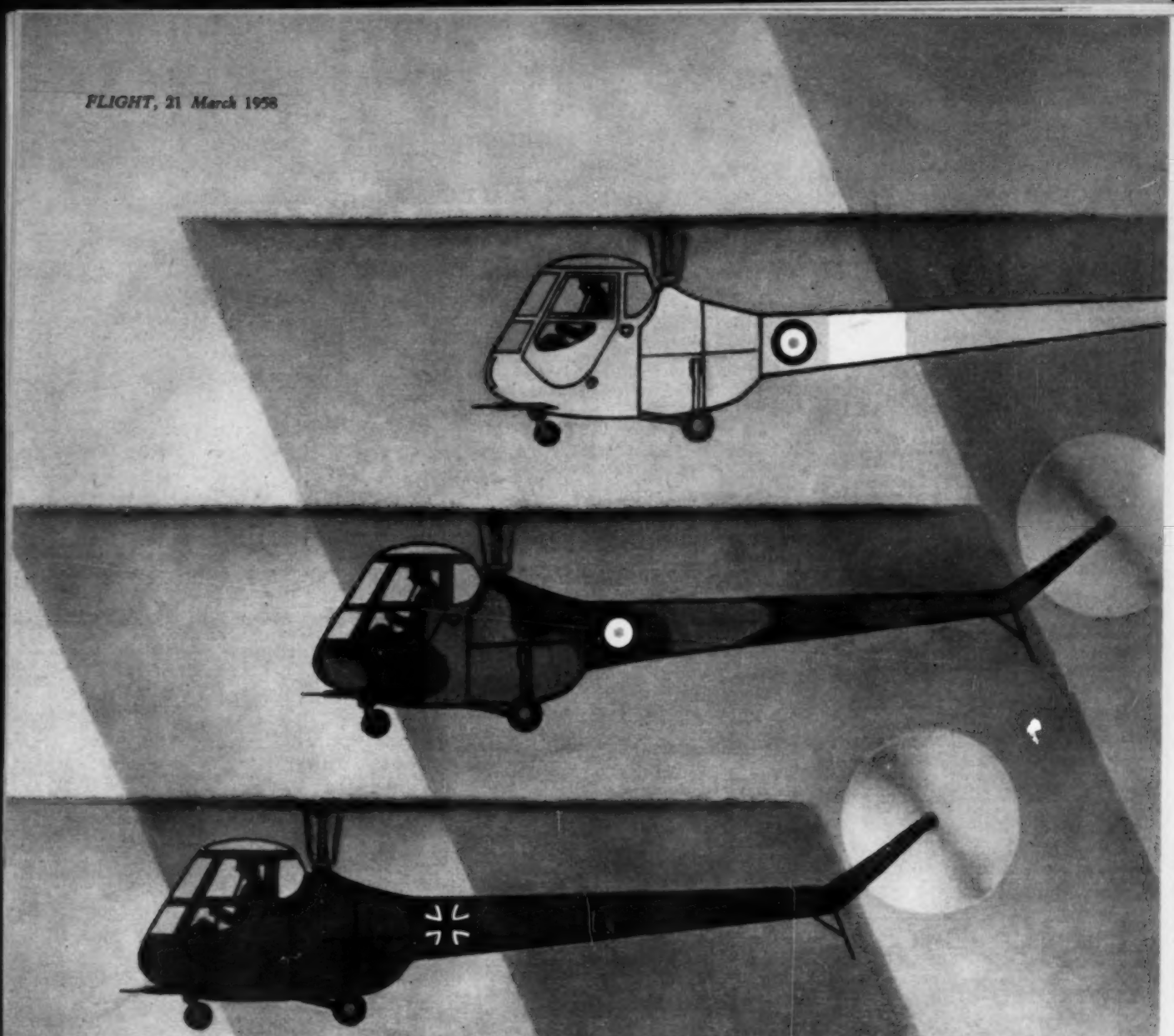
Nor is it the limit of simplicity, for Rotor-Craft's forthcoming Sky Hook helicopter will weigh less than 75 lb, fit into an "over-sized suitcase," and offer an assembly time of two minutes, without tools.

At sea, too, the military helicopter has a great part to play. Already it has been developed to the stage where the Royal Navy is able to plan the use of helicopters exclusively for anti-submarine duties. Last year's S.B.A.C. Display gave a first glimpse of such an aircraft, when a Whirlwind H.A.S.7 appeared with a recess for a homing torpedo under its cabin. This was a logical development, for a helicopter has the ability to hover over the suspected position of a submarine and hunt it down with sonar "listening" gear. It can operate from a small platform on almost any ship, and so reduce the need for carriers for convoy protection, and it should be able to provide better all-weather anti-submarine cover than either land-based or carrier-borne fixed-wing aircraft.

The turbine-powered Wessex should be ideal for anti-submarine work, carrying rockets, torpedoes or depth charges. It will also be useful for reconnaissance when no other aircraft are available; but a machine like the Fairey Ultra-Light or Sud Aviation Djinn would be better, because its tiny bulk would offer a chance of seeing over the horizon without being seen itself.

Use of helicopters for all these duties ashore and afloat would require production in such great numbers that the aircraft industry would receive a powerful shot in the arm to help it recover from the shock of reduced orders for bombers and fighters. It would cost a great deal of money; but, quite apart from military

Keeping the current flowing: A Sikorsky S-58 (left) was used recently to plant 63 power-line poles in previously-dug holes on an almost inaccessible mountainside. (Below) Power-line patrolling, using light helicopters like the Bell 47J seen here, is carried out on annual charter basis by several United States operators.



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necessity, would provide splendid dividends in the form of fully developed helicopters that would be equally suitable for civil use, whereas only space-dogs have yet made a journey (one-way) by the still-more-costly ICBM.

This brings us back again to Russia, whose military leaders appear to be fully convinced of the value of helicopters, if we are to judge by the vast numbers of Mi-1s, Mi-4s and Yak-24s that dispense troops, guns, trucks and equipment at each Tushino display. And these same aircraft are in parallel production for Aeroflot.

The Helicopter Airways. No statistics are available showing the extent to which Aeroflot is already using helicopters; but it must be fairly great if we include such work as spraying and dusting, for which this airline is also responsible. However, it is probably safe to assume that no other operators in the world have the scheduled service experience of Sabena and America's three pioneer companies, New York Airways, Chicago Helicopter Airways and Los Angeles Airways.

Study of their results shows once more that the helicopter is not doing too badly, despite the critics, and despite the fact that it operates only short stages, which are traditionally uneconomical even with fixed-wing aircraft. In the single month of July 1957, New York Airways carried 9,100 passengers in its nine comparatively small helicopters. This was 18 years after the first flight of the first practical "single rotor" helicopter. Yet in the whole of 1926, which was 23 years after the first practical aeroplane flight, the eight scheduled airlines then existing in the United States carried a total of only 5,782 passengers. Furthermore, New York Airways also hauled 60,000 lb of freight, 122,000 lb of express and 250,000 lb of mail in that same peak month last summer.

So popular are the services run by the three U.S. companies that last year their passenger traffic increased by 118 per cent and freight by 114 per cent—which is not bad by any standards.

Of course, the cynics will say that the more passengers a helicopter airline carries, the more money it loses, and to a large extent this is so. Economic aspects are discussed in an article on page 388, but we can add another sidelight here. According to Jules Naomé, *Attaché à la Direction* of Sabena, "direct operating costs, including depreciation but excluding hull insurance, of the S-55 on the Sabena network was about 17 cents (say 14.6d) per seat-mile, while the seat-mile on the S-58 costs about 14 cents (12d). Although this may seem an appreciable reduction in operating costs, the true picture is given when costs per seat-mile are related to the average income per passenger-mile. The real income per passenger on our network is about 7 cents (6d) per passenger-mile or, at a 50 per cent load factor, 3.5 cents (3d) per seat-mile. This means that the deficit on direct operating costs alone and at a 50 per cent load factor is around 81 cents (69.4d) per mile for the S-55 and around $1.26 (108d) per mile for the S-58."

New York Airways have the good fortune to operate in a city where the Port Authority believes in helicopters. As a result, its present heliports at Newark Airport, La Guardia, Idlewild and West 30th Street will be supplemented progressively with new heliports at Brooklyn, the Battery, East Side Manhattan, Staten Island and Newark, at a cost of $20 million, as its services build up.

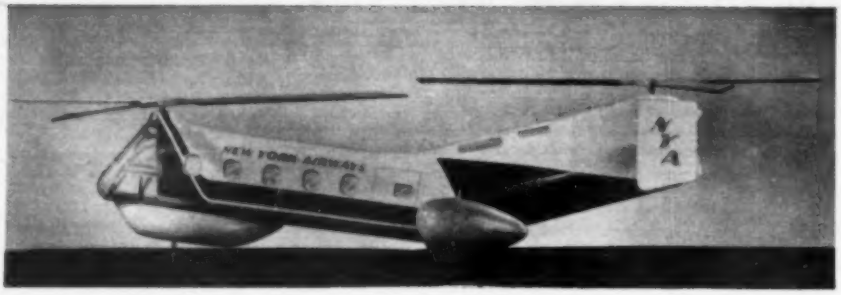
A first major step towards the goal of economic independence was taken recently when New York Airways ordered five tandem-rotor Vertol 44Bs to replace its present fleet of smaller aircraft. Each will carry 15 passengers, plus mail, freight and baggage in a 45 cu ft cargo compartment, and the first is expected to be delivered in April.

Later, possibly in 1960-61, the airline hopes to begin re-equipping with what it calls "Ship X." This is seen as a twin-turbine helicopter carrying 20-25 passengers over a range of 125 miles at 100-125 m.p.h. and corresponds with the first of the two "specifications" that resulted from the I.A.T.A. Helicopter Meeting at San Remo in May 1956. Its initial cost is expected to be around $500,000 (£180,000), with a direct operating cost of not more than $95 (£34) an hour and maintenance cost of $95 (£34) an hour. Nor is this a mere dream, for Vertol are building an aircraft to meet this sort of specification, and hope to have it flying in the next two or three months.

Assuming the availability of efficient all-weather navigation aids (the company decided recently to fit the Decca Navigator to its fleet), it is hoped to have five "Ship Xs" in service by 1962 and to carry nearly one million passengers in that year. Doubling the fleet and operating at a load factor of 60 per cent, New York Airways believe they would carry nearly 2½ million passengers in

In scheduled service: A Sikorsky S-58 of Chicago Helicopter Airways.

WHO BELIEVES IN HELICOPTERS?...



The striking blue, grey, white and red livery designed for New York Airways' Vertol H-44s. The "rocket red" is in Day-Glo fluorescent paint, intended to make the aircraft easily visible to the pilots of others.

1965, bringing in over $9 million revenue and enabling them to dispense with a subsidy. It is interesting to conjecture what the results would be if 48-seat Rotodynes were substituted for the smaller, slower and less economical "Ship X."

If 2½ million passengers a year in one city sounds fantastic, it is well to remember that studies conducted by the Port of New York Authority and other competent organizations have put the anticipated helicopter traffic even higher. In fact, the U.S. Aircraft Industries Association has predicted an "almost explosive" growth in traffic between 1961 and 1965, to the extent that it expects some 30 million civil helicopter landings and take-offs by that year. By comparison, there was a total of 20,384,000 landings and take-offs by civil and military aircraft at all airports with C.A.A. control towers in 1956. It is anticipated that ten million of the helicopter landings and take-offs will be made by commercial operators, which exceeds U.S. domestic air carrier operations in 1956 by 50 per cent. This estimate is based on the anticipated use of 800 transport helicopters, which would be equivalent numerically to the U.S. domestic fixed-wing airline fleet in 1947.

The other 20 million landings and take-offs would be contributed by non-scheduled carriers, business helicopters and operations that come under the category of "general aviation," and which are expected to account for 25-30 per cent of future helicopter sales. This must also seem terribly optimistic to anyone living in the United Kingdom, *sans* scheduled helicopter services, *sans* helicopter-minded businessmen (except for a few pioneers like Richard Fairey) and *sans* much initiative or encouragement from Government, industry or manufacturers. But again it is worth while turning our eyes westward, for there were 65 helicopters engaged solely on business flying in America a year ago, and since then one or two bright operators have been cashing in on the vast untapped potential of this market.

Typical is Helicopter Air Lift of Chicago, whose founder, Hal Conners, decided in the autumn of 1955 that there must be several senior executives in the city's 6,000-odd industries who would be willing to pay a reasonable annual fee for the convenience of having a helicopter permanently at their disposal for business trips. He was so persuasive that four leading companies —Motorola, Shell Oil, Texas-Illinois Natural Gas and Union Tank—soon agreed to use 200 hours of helicopter taxi service apiece each year. This enabled him to buy a three-seat Bell 47 at $35,000 and to be assured of an annual profit from operating it. Then the idea snowballed. In a few months he had four 47s, to which he has since added a four-seat 47J, and his list of subscribers now reads like a directory of Chicago's top industry.

Customers can buy as little as 25 hours' flying at $75 an hour. The rate drops to $65 for 100 hours and even less for larger users. Nor is such a service practicable only in places with proper heliports, for H.A.L. helicopters operate regularly into 60 factory and office landing sites in Chicago, where it has been found that almost any roof strong enough to bear the sort of snowfall the city gets can also support a Bell 47.

This is only one bright idea, and only one way in which the helicopter is being used by industry and commerce in America. A single operator in Canada, Okanagan Helicopters, is able to find charter work for a fleet of 57 helicopters, made up of 36 Bells, 20 S-55s and one S-58, on work ranging from geological surveying and power line patrol to "flying crane" operations into sites perched frighteningly on mountain ledges. A U.S. operator, flying for the oil industry, carried some 150,000 people between off-shore drilling rigs and shore installations last year. In this respect, the variety of work that has been undertaken by helicopters is well known. Almost every one could be developed from dabbling to dividends by an operator with imagination.

What is the potential for the future? It is impossible to say; but the U.S. oil industry alone operates well over 1,700 aircraft at the present time; and the helicopter will do anything that a fixed-wing aeroplane can do, and more besides, except where high airport-to-airport speed is the prime need. To the business and commercial market must be added the unknown "personal helicopter" market that may await a cheap, easy-to-fly machine like the Rotor-Craft Sky Hook, or a mass-produced tip-driven Skeeter, or a development of the ducted-propeller Piasecki 59X, which is only a different kind of helicopter.

Much work is being done, on both sides of the Atlantic, in the development of helicopter flight simulators. This is Short Brothers' new equipment, with dual-control cockpit (at left) and, below it, a horizon projector. Another projector, above the cockpit, gives the seascape.

Social call: Back garden possibilities of the Gyrodyne XRON-1.

These are markets that will endure even if the armed Services and airlines progress one day to some other form of VTOL or STOL design such as the tilt-wing aircraft, because there are literally millions of potential customers for a cheap, safe, easy-to-fly "family car of the air." Perhaps they are best typified by an 87-year-old Belgian harness-maker named Fleune DeCroupet, whose simple, moving little story was told in a recent issue of the United Aircraft Corporation's magazine, *Bee-Hive*.

It seems that last summer a relative presented DeCroupet with the winnings of a lottery so that the old man could fulfil a lifelong wish to see the Cathedral of Cologne. There, generations ago, a member of his family had been honoured for service to his church.

Shortly after he took off from Liege in a Sabena S-58, DeCroupet's eyes lit with excitement. He sat silently, seemingly transfixed by his novel experience. Fifty-one minutes after take-off the helicopter was over Cologne. As the old man looked down on the twin spires of the beautiful Cathedral almost at his fingertips, his eyes filled with tears and he spoke for the first time during the flight. In deep, resonant tones, he said:

"Voici comment Dieu voit." (This is how God sees.)

ROTOR POWER

SINCE 1950 the British aircraft industry has investigated a remarkable variety of rotary-wing aircraft. In particular, many quite novel types of propulsion system have been explored, and although several of these projects have not borne commercial fruit, we still have a range of helicopter powerplants which are second to none. These illustrations depict recent power units by five leading British engine companies.

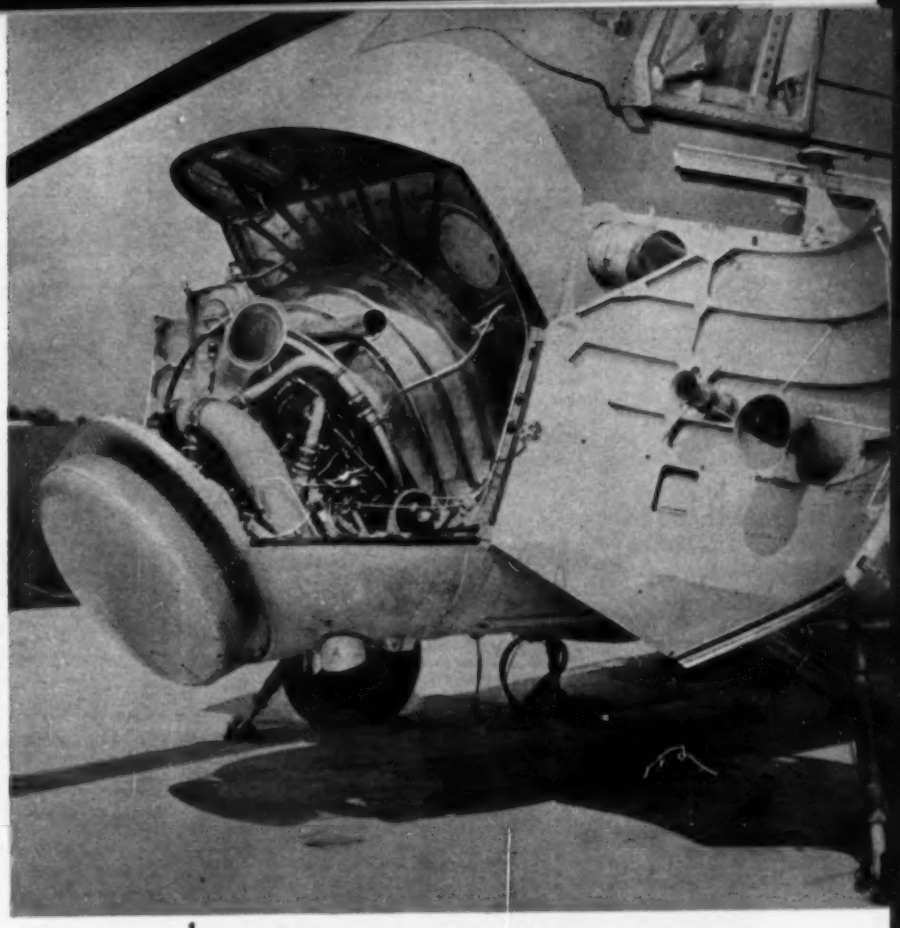
(1) D. Napier and Son, Ltd., are in production with two types of Gazelle free-turbine engine; the NGa.2 fits the Bristol 192, and the photograph shows the NGa.13 in the Westland Wessex.

(2) Armstrong Siddeley Motors' new turboshaft unit for helicopters is the P.181, with ratings starting at 1,000 h.p. (described in our February 14 issue).

(3) de Havilland Engines will licence-produce the General Electric T58 1,000 h.p. free-turbine unit as the Gnome. These T58s are installed in a Sikorsky HSS-1.

(4) Alvis power the great majority of British helicopters at present flying. The picture shows a Leonides Major installed in a Whirlwind AS.7.

(5) Blackburn and General Aircraft have a wide range of small turbines in the 350/450 h.p. bracket. This is the Palouste air-compressor which powers the Fairey Ultra-Light.



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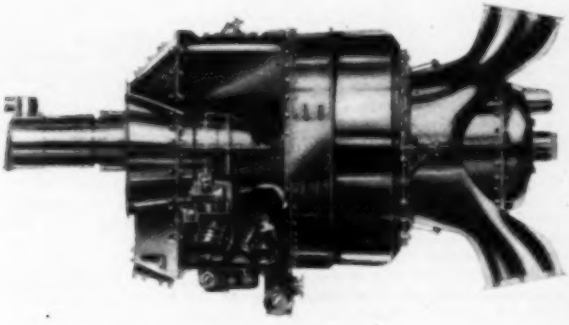

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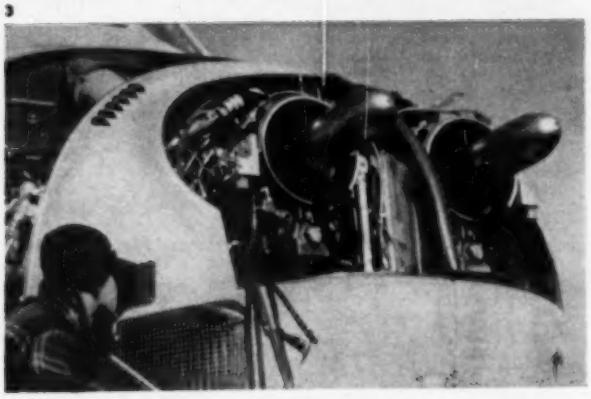

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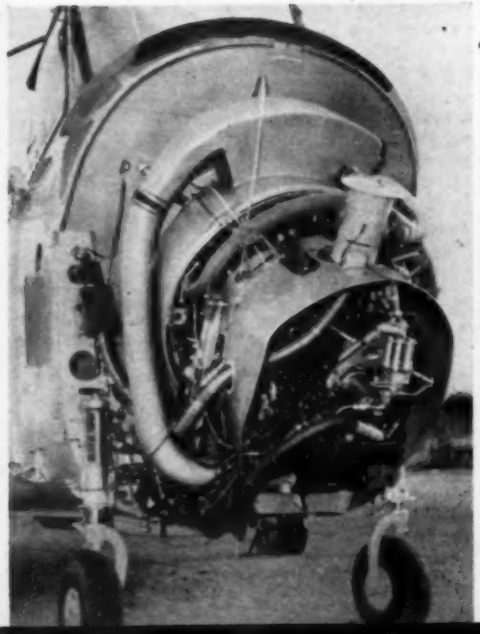

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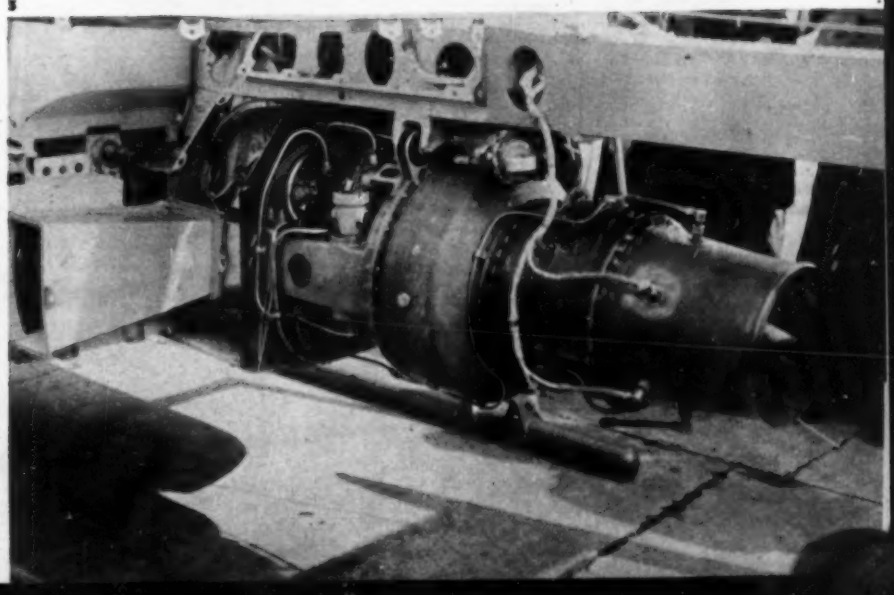

5

HELICOPTERS IN CIVIL OPERATION

WHY ARE SO FEW ENGAGED ON SCHEDULED SERVICES?

By JOHN SEEKINGS

IT is almost five years since the first scheduled helicopter service for passengers began. In July 1953, New York Airways put their newly acquired Sikorsky S-55s into service between the city's three main airports, Idlewild, La Guardia and Newark. Within two months the first European—and first international—scheduled service was initiated by Sabena, on a route running from Brussels to Rotterdam *via* Lille and Antwerp. In November 1954 Los Angeles Airways started passenger services between the International Airport and the heliport at Long Beach, a 12-minute flight as against an hour's drive. The following July saw British European Airways introduce a service linking London Airport to South Bank alongside Waterloo Station; and in November 1956 Chicago Helicopter Airways (then Helicopter Air Services) started a passenger service between Chicago's two airports—Midway and O'Hare—and Meig's Field heliport.

All these five pioneering carriers—N.Y.A., Sabena, L.A.A., B.E.A. and C.H.A.—used similar equipment, seven-seat S-55s. All five, too, had prior experience of helicopter operations, using Bell 47s, Sikorsky S-51s and (in the case of B.E.A.) Bristol 171 Sycamores. To Los Angeles Airways falls the credit for the first scheduled service: they flew regular mail deliveries as far back as October 1947. B.E.A. and C.H.A. ran mail services in 1948, and in 1950 Sabena contracted with the Belgian post office to deliver mail in Bell 47s on a cost-plus basis. B.E.A. also ran an experimental passenger service with Sycamores from June 1954 until May 1955. This service, between London and Southampton, carried only 986 passengers. Their scheduled service between London Airport and Westminster was equally short-lived, terminating in May 1956 after having being patronized by 3,800 travellers.

Another pioneering company, Ostermans Aero, have carried out regular mail delivery between Stockholm and various points in the neighbouring archipelago every winter since 1948. As was the case with B.E.A., this company's passenger operations were of brief duration, a helicopter link between Sweden and Denmark having been flown for a few months during 1955 with S-55s.

Unlike B.E.A. and Ostermans Aero, the other four pioneers have persisted with scheduled passenger operations and are now each carrying traffic at an annual level of about 1½m passenger-miles. (To put this into perspective, a single Dove would carry a like amount of traffic in a typical year's operation.) With the sole exception of Los Angeles Airways, all the airlines currently operating scheduled helicopter services have graduated to larger aircraft in the form of the 12-passenger S-58. But even this has proved too small a vehicle; New York Airways are in the process of replacing their Sikorsky fleet of five S-55s and three S-58s by five Vertol 44Bs. These 15-seat aircraft will double N.Y.A.'s present annual seat-mile capacity from 2.5 to 5.0m. Sabena is also conducting evaluation tests on the Vertol 44.

The factor governing the helicopter's slow development can be simply described: how heavy is the loss that can be afforded? In the U.S., where scheduled services are certainly as intensively and efficiently operated as anywhere, total operating costs are almost $7 (£2 10s) per capacity ton-mile. This compares with under 30 cents per c.t.m. for America's domestic trunk airlines, and about 50 cents for her local-service carriers. Rotary-wing aircraft in use today are still 15 to 25 times as expensive to operate as their fixed-wing brethren.

The peculiar advantages of the helicopter allow passenger fares to be set at rates which would ordinarily be prohibitive. A steady fall in the average fare, from 38 to 28 cents per passenger mile, has been accompanied by a rise in seat load-factors from under 20 per cent to about 50 per cent. This is still quite inadequate to cover operating costs. In the U.S., the three scheduled helicopter operators have been kept alive by mail rates averaging $30 (£10 14s) per ton-mile (the domestic trunk carriers are getting 37 cents (32 pence) per mail ton-mile, while the local-service carriers get $1.53—about 11s—per t.m.). These generous rates include a large proportion of subsidy. In the present financial year, C.A.B. subsidy for helicopter services stands at $4.5m (£1.6m). For the year 1958-1959 this is expected to fall to $4.1m (£1.5m). Sabena publishes no financial results for its helicopter services, but no trouble is taken to conceal the fact that they are run at a loss. B.E.A. also lost heavily on its helicopter operations, costs over the last four years having exceeded revenue by over £½m (of which about three-quarters was borne by the Government in the form of subsidy).

Four big helicopters—three Western, one Russian—show promise of subsidy-free operations: the Fairey Rotodyne, Westland Westminster, a Vertol derivative and the Mi-6. If the expectations of their makers are fulfilled, these aircraft will be the first to bring scheduled helicopter operations into the hard-headed world of unsupported private enterprise.

The unsuitability of the helicopter for scheduled services has not deterred private companies from exploiting the non-scheduled market. Against the total fleet of 37 helicopters in scheduled civil operation (seven Bell 47s and 30 Sikorskys) about 350 are performing non-scheduled services. Precise figures are difficult to establish, but it seems that at least 200 are being operated in North America, 40 in Latin America, 70 in Europe, and 40 elsewhere. Unlike the scheduled operators, the charter companies prefer smaller aircraft. The Bell 47 is the most popular aircraft in this field, some 150 now being in use, while Hiller have sold about 70 civil helicopters. Sikorsky sales are less than 50.

Although the typical non-scheduled helicopter operator is a small company employing a fleet of less than five aircraft, there are—scattered around the world—a few really large-scale undertakings. The North American scene is dominated by four such companies, Rick and Bahama in the U.S., Okanagan and Spartan in Canada. Rick Helicopters, together with their associates Alaska Helicopters and U.S. Helicopters, control a fleet of 30 aircraft. Bahama Helicopters (nominally based at Nassau) are linked with Agricultural Helicopters, Armstrong-Flint Helicopters and World Wide Helicopters; their total fleet also numbers about 30. Okanagan is based in British Columbia and, together with its subsidiaries, United and Canadian, can claim to be the world's largest operator of helicopters, the total fleet consisting of 36 Bell 47s, 20 S-55s and one S-58. Spartan's 14 Bell 47s concentrate on photographic survey.

Throughout the rest of the world there appear to be only seven companies with over five helicopters each. Three are to be found in Latin America: Trabajos Aereos y Representaciones (13 Bell 47s) in Argentina; Aerotechnica (ten Bell 47s) in Venezuela and Helicol (six Bell 47s) in Colombia. The remaining three are in Europe, two being in France (Etablissement Fenwick and Cie. Gyrafrique, with fleets of eleven and seven Bell 47s respectively) and one in the U.K. (Fison-Airwork, with three S-55s and six Hiller 360s).

New York Airways are to re-equip with Vertol 44Bs, largest helicopters available for civil use.

TESTING TIME FOR METALS

Bench testing a Bristol Proteus 755 turbo-prop as used in the Britannia airliner.

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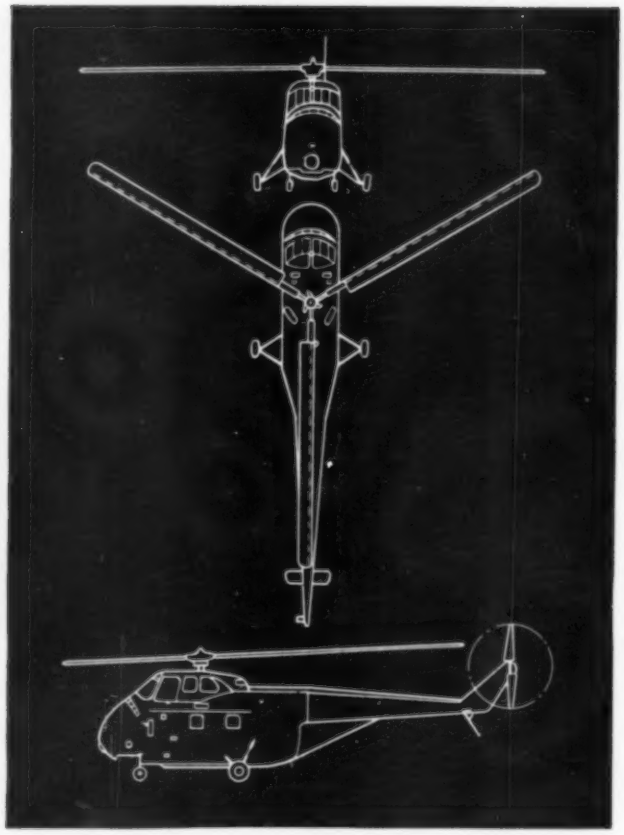

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Westland Whirlwind cockpit (Photograph by courtesy of B.E.A.)

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PAL3

Left, Motoimport SM-1. Above, BZ-4 Zuk.

Helicopters of the World . . .

(*continued from page 378*)

POLAND

Motoimport

Przemyslowa 26, Warsaw.

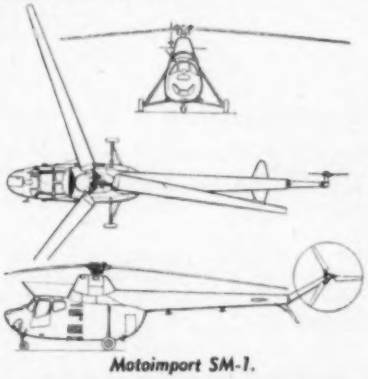
SM-1 Built in the PZL works at Swidnik, this is the Polish version of the Soviet Mi-4 helicopter and is powered by the Russian AI-26W seven-cylinder 575 h.p. engine. Behind the pilot's seat is a bench seat for two passengers with parachutes, or three without parachutes. The SM-1, like its Russian counterpart, is suitable for operation in Arctic conditions, and the fuel system embodies special arrangements for oil dilution. A maker's description runs: "The anti-freezing system prevents the forming of ice on main rotor blades, tail rotor blades and on the windscreen by means of washing their surfaces with special antifreezing fluid. Beside that the windscreen is heated from the inside of the cabin by means of a hot air flow. Antifreezing fluid is spread on the windscreen surface by means of a wiper. The main tank containing antifreezing fluid is of six Imp. gallons capacity and the auxiliary tank can take 0.6 Imp. gallons." The SM-1 is at present being adapted for agricultural and ambulance work.

● Rotor diam., 47ft; fuselage length, 40ft 9in; gross weight, 4,950 lb; empty weight, 3,927 lb; max. speed at s.l., 124 m.p.h.; max. vertical rate of climb at s.l., 1,280ft/min; hovering ceiling, 9,840ft; service ceiling, 16,400ft; max. range at 87 m.p.h., 240 miles.

BZ-4 Zuk Powered with a 320 h.p. WN-4 seven-cylinder radial engine, the Zuk is a 3/4-seater with a covered-in forward fuselage and an open boom—both of tubular-steel construction. The aircraft can serve as an ambulance carrying an attendant and a stretcher case, or it can be fitted with dual controls.

● Rotor diam., 39ft 4in; overall length, 41ft 10in; empty weight, 2,300 lb; gross weight, 3,300 lb; cruising speed, 78 m.p.h.; service ceiling, 9,850ft; range, 160 miles.

Kotlinski Trzmiel This experimental helicopter has two pulse-jet units mounted at the rotor tips.



Motoimport SM-1.

SOVIET UNION

Kamov

Ka-10 The basic design of this single-seat utility helicopter, as used by the Soviet Navy, is now about ten years old. As on the other Kamov helicopters described on this page, a co-axial rotor system is employed, and pontoons are often fitted. The picture shows a relatively early model, a variant (Ka-10M) now having twin fins.

● Approximate data: Rotor diam., 20ft; gross weight, 830 lb; max. speed, 70 m.p.h.

Ka-15 This neat two-seater helicopter has an AI-14R nine-cylinder radial engine which drives co-axial rotors, largely of wooden construction. The fuselage is principally of metal.

● Approximate data: Cruising speed, 75 m.p.h.; hovering ceiling, 2,200ft; service ceiling, 9,800ft.

Ka-18 The Ka-18 is essentially a four-seater version of the Ka-15, having a lengthened and redesigned forward fuselage differing greatly in appearance from that of the Ka-15. Quantity production is in hand.

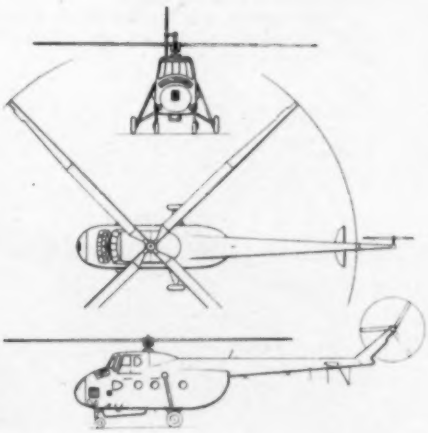
Mikhail Mil

Mi-1 (Hare) This very widely used Soviet helicopter is referred to—as the SM-1—under "Poland," where it is licence-built.

Mi-3 (Hare) A development of the Mi-1, having greater fuselage and lifting capacity and a four-blade rotor, this helicopter has provision for panniers on the fuselage sides. These serve for ambulance work or freighting, or they can carry extra fuel or agricultural chemicals. Gross weight is probably of the order of 5,200 lb.

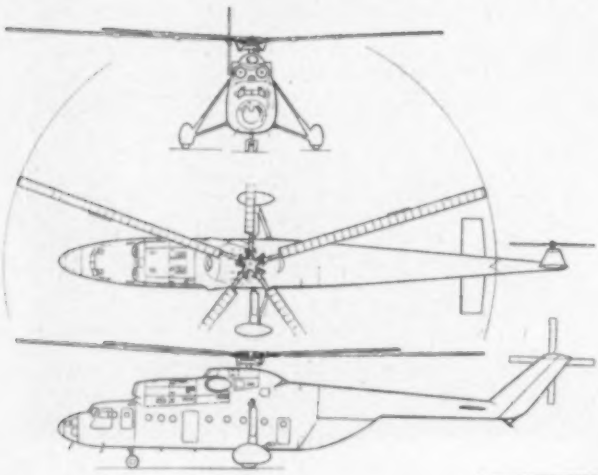
Mi-4 (Hound) The Mi-4 is generally considered to bear the same relationship to the Mi-1 and 3 as does the Sikorsky S-55

Kamov Ka-10.



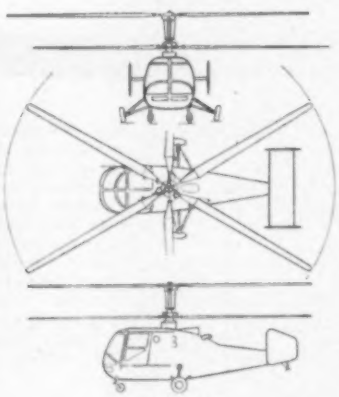
Below and right, Mi-4 (Hound).

Helicopters of the World . .



Above and left, Mi-6.

Lower left, Winicki helicopter (designation unknown). Bottom right and immediately below, Kamov Ka-15.



to the S-51, though its designer claims that it has twice the gross weight, engine power and lifting capacity of the S-55. He further claims that when the Mi-4 went into production at the end of 1952 it had no equal abroad—was, in fact, several years ahead of anything then being turned out by foreign manufacturers. Several variants are in operation. The normal military model can accommodate the Soviet equivalent of the jeep, a small car, a 75 mm anti-tank gun, or two motor-cycle sidecar combinations. Fourteen armed soldiers are another possible load.

The variant used by Aeroflot is known as the Mi-4P and seats ten passengers while providing ample space for luggage. This version is characterized by square—instead of round—windows, and there is no underslung gondola for the navigator, as on the military machine.

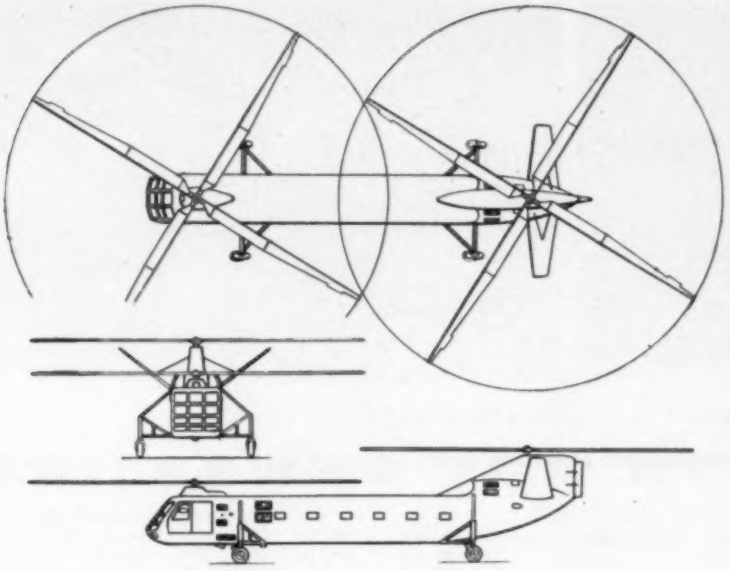
The agricultural version is the Mi-4S and the gondola is used in this model as a distributing point for chemicals. Spray booms can be attached to the fuselage. Closely related to this aircraft is a special fire-fighting development.

The standard powerplant of the Mi-4 series is the ASH-82V developing 1,700 h.p. Provision is made for blind- and night-flying, and there is an anti-icing system, as on the smaller Mi types. The four-bladed main rotor has hydraulic servo control. A notable feature of the metal fuselage is the clamshell doors at the rear.

A number of records have been established by Mi-4s, and on April 26, 1956, one of these machines attained a height of 19,840ft with a load of two metric tons. This was not, however, quite a standard aircraft.

● Rotor diam., 58.9ft; gross weight, 15,870 lb; typical load, 2,650 lb; max. speed, 130 m.p.h. approx.

Mi-6 This is the world's largest helicopter, and in several respects (notably the geometry of the rear fuselage and tail boom) it resembles its smaller predecessors. The five-blade rotor is reminiscent of that of the Sikorsky S-56 and, together with its propulsion machinery, clearly forms a self-contained unit to which could be attached a variety of fuselages or structures suitable for "flying crane" applications. The turbines are of the 4,700 h.p. TB-2BM type, with drive output shafts at the rear end. The engines are apparently



coupled to a common gearbox provided with clutches and free-wheels giving a final shaft drive to the hub of the rotor. Photographs show what appear to be an intake for the oil coolers between the main engine intakes; bifurcated outlets for the out-turned exhaust trunks; and an intake serving the gearbox oil coolers.

All this indicates that the Mi-6 is identical in configuration with the Westland Westminster (two Napier Elands); but it is rather larger than the British machine and it is also many months earlier in timing. It is a very remarkable achievement to have designed, developed and flown the Mi-6 and to have brought it to a state of development where it can gain a world record under observed conditions. The previous load-to-height record was 6,010 kg (13,250 lb) which a Sikorsky S-56 lifted to 6,560ft. On October 30 the Mi-6 flew to 7,874ft with a commercial load of 12,004 kg (26,464 lb). An accompanying Soviet announcement stated that the Mi-6 can carry 70 to 80 passengers as well as heavy equipment and vehicles; it was claimed that series production was "about to start."

Winicki

Undesignated Helicopter Powered by a 260 h.p. AT-14 engine, this helicopter is shown in an accompanying photograph (possibly of a model).

● Rotor diam., 36ft; empty weight, 1,785 lb; gross weight, 2,865 lb; max. speed, 93 m.p.h.; cruising speed, 71 m.p.h.; range, 215 miles; hovering ceiling, 3,280ft; absolute ceiling (two up), 13,750ft.

Yakovlev

Yak-24 (Horse) Another very impressive Soviet helicopter, the Yak-24 has been in service with the Soviet Air Force for at least three years. It is powered with two 1,700 h.p. ASH-82V fourteen-cylinder radial engines driving rotors similar to those of the Mi-4. The "box-car" fuselage is of steel tube construction, the centre portion being fabric-covered and the extremities having metal panelling. Combined with the rear section of the fuselage is a loading ramp for wheel or track vehicles and heavy military equipment. The cabin measures some 33ft in length and will accommodate two lorries or jeeps, a twin 14.5 mm anti-aircraft gun with its crew, or as many as 40 troops with their service equipment.

During December 1955 a Yak-24 lifted two metric tons to a height of 16,670ft.

● Rotor diam., over 56ft; gross weight, over 35,000 lb; cruising speed, 110 m.p.h. approx.; range, 500 miles approx.

Upper left and above, Yak-24 (Horse).

SPAIN

Aerotecnica, S.A.

Velazquez, 38, Madrid.

AC-12 This light two-seater helicopter is powered by a Lycoming O-360 engine of 170 h.p. mounted above the cabin and driving the rotor through a gearbox. The cabin seats two side by side and there are dual controls.

● Rotor diam., 27ft 10in; overall length, 27ft 9in; empty weight, 1,055 lb; gross weight, 1,585 lb; max. speed, 75 m.p.h.; cruising speed, 63 m.p.h.; absolute ceiling, 16,000ft.

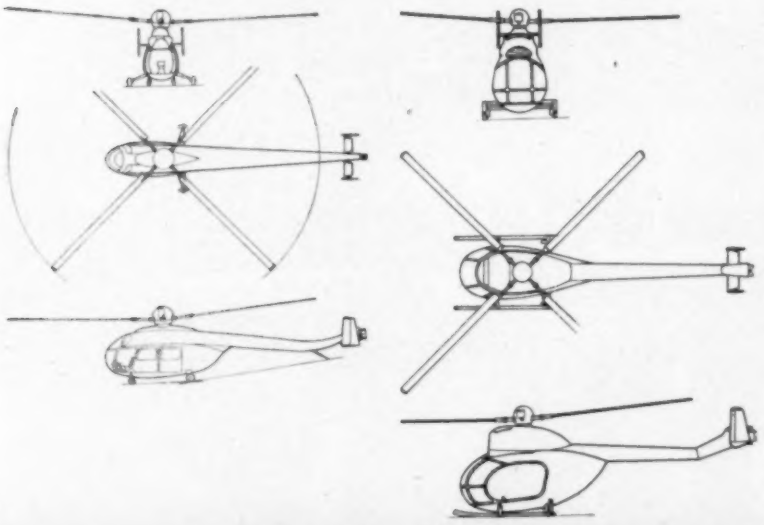
AC-14 The five-seater AC-14 is a version of the earlier AC-13 three-seater, powered by a 320 h.p. Turboméca Artouste II gas turbine. The accompanying photograph shows the aircraft with the cabin sides removed.

● Rotor diam., 31ft 6in; empty weight, 1,370 lb; gross weight, 2,650 lb; max. speed, 112 m.p.h.; cruising speed, 99 m.p.h.; ceiling with ground effect at max. weight, 21,000ft.

AC-15 A projected two-seater helicopter with a Lycoming VO-435 h.p. engine of 260 h.p.

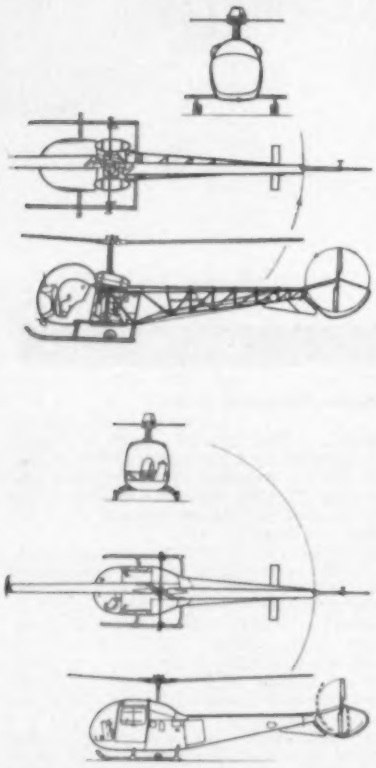
AC-21 A projected helicopter having two Turboméca Turmo III engines of 750 s.h.p., an empty weight of 4,400 lb, a service ceiling of 32,000ft, and seating twelve (including crew). Normal still-air range will be 590 miles. Rotor diameter is 55.6ft.

Below left, Aerotecnica AC-21. Below and extreme right, Aerotecnica AC-14.



Above, Bell Model 47J Ranger. Below, Bell Model 47G-2.

Above, Bell Model 47G-2.



Helicopters of the World . . .

Bell Helicopter Corporation

Fort Worth 1, Texas.

47G-2 This version of the familiar Model 47 has a Lycoming VO-435 engine delivering 200 h.p. (derated from 260 h.p.) but otherwise resembles the earlier "47" variants. The makers describe it as an ideal hot-weather, high-altitude helicopter, capable of hovering in ground effect at more than 10,000ft at maximum gross weight. The three-seater commercial model is particularly suited for crop-dusting and spraying, and for patrol, survey and rescue work. The U.S.A.F. and Army version is the H-13H, now known as the Sioux. One of these machines has remained continuously airborne for 57 hr 50 min. In military service the type is used for casualty evacuation, observation, reconnaissance, wire-laying and training among other duties.

● Rotor diam., 35ft 1in; overall length, 41ft 5in; empty weight, 1,565 lb; gross weight, 2,450 lb; max. speed, 100 m.p.h.; hovering ceiling in ground effect, 15,700ft; range, 250 miles.

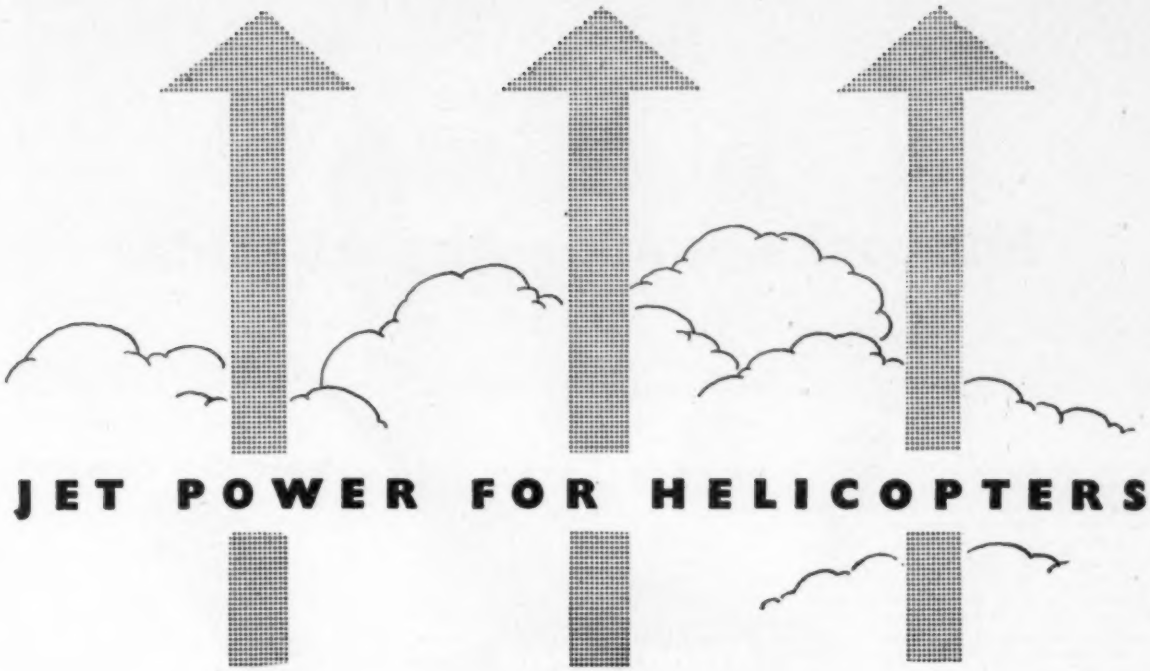
47J Ranger This de luxe development of the 47 carries a pilot and three passengers. The commercial model is delivered with standard or de luxe interiors and can be equipped with an internal hoist without the use of special tools. Other optional accessories include floats, twin internal stretchers, radio, heater and long-range fuel kit. The U.S.A.F. version is designated H-13J and has been used by the President and his staff. U.S. Navy models are designated HUL-1.

The normal cabin arrangement provides for the pilot's seat to be located at the centre of the cabin. Aft of the pilot's seat is a foldable passengers' seat which provides ample room for three passengers. The main rotor is a two-bladed, see-saw type. The blades are of wooden construction, incorporating a corrosion-resistant steel abrasion strip on the leading edge. Provision is made for balancing the rotor spanwise at the tip of each blade. The blades are covered with a woven fabric material and doped. The root area is reinforced with metal of sufficient strength to insure adequate attachment to the hub. A ground-adjustable trim tab is provided on the outer trailing edge of each blade for tracking the rotor system. Life of the rotor blades is not limited. A stabilizer bar is provided to improve stability. This bar provides an absolute reference base in respect to which the rotor is controlled independently of the body attitude. Temperature compensated hydraulic dampers are provided for controlling the action of the bar.

The Ranger being something of a "luxury" helicopter, the following extract from the makers' description headed "Paint and Interiors" is of particular interest:

"The Model 47J Ranger is available in three versions: standard, deluxe and custom. The standard model is upholstered in light grey with foam rubber seat cushions and with sound insulating padding on firewall, overhead and door panels. The exterior of this helicopter is painted maritime aluminium with harmonizing

Above, Bell 47J Ranger. Below, Bell XV-3 (in wind tunnel).



JET POWER FOR HELICOPTERS

The trend of development in providing power for helicopters has moved rapidly towards the gas turbine, which offers distinct advantages in high ratio of power to weight, flexibility, reliability and the use of safer fuels common to fixed-wing jet aircraft.

For the smaller types of helicopter the turbine designs of Turbomeca have established a unique position: French engines and the Blackburn derivatives supply the power in practically every design where the small turbine engine is installed.

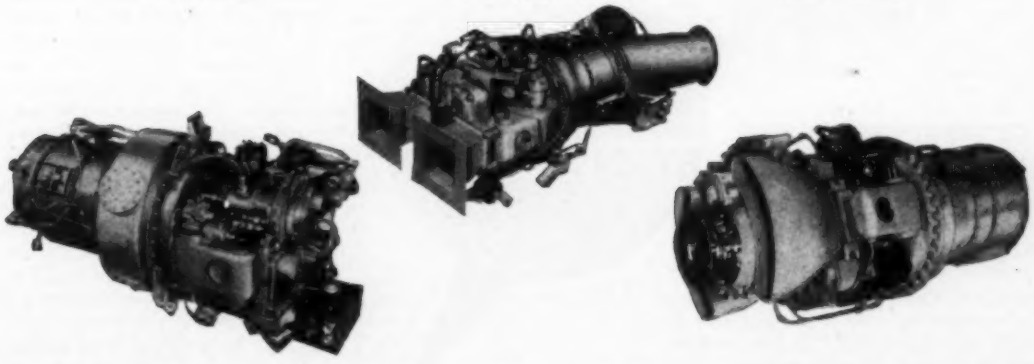
In France the well-known Djinn has a Turbomeca Palouste and the Alouette a Turbomeca Artouste. In the United States of America the Kaman Corporation uses the Blackburn Turmo and in Great Britain the Fairey Ultra-Light is powered by the Blackburn Palouste. A number of other helicopter projects are proposed, using these jet power plants.

The Blackburn range developed from Turbomeca units consists of the

PALOUSTE
AIR BLEED

TURMO
FREE TURBINE

ARTOUSTE
FIXED SHAFT



BLACKBURN GAS TURBINES

(LICENSEES FOR TURBOMECA ENGINES)

BLACKBURN & GENERAL AIRCRAFT LIMITED
ENGINE DIVISION 43 BERKELEY SQUARE, LONDON W.1

E102/a

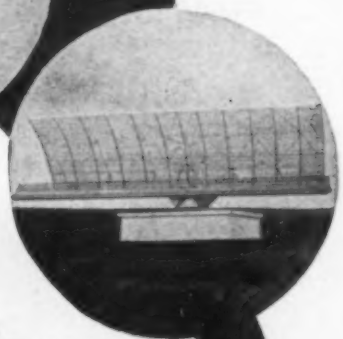
Marconi's hand in Airport Radar

Planning and Installation of Military and Civil Radar Systems

TYPE SNW 51

TYPE SNW 51 3 cm STORM WARNING RADAR

Storm Warning Radar can now be recognised as an important element of an Airport Radar system.
The SNW 51 provides an accurate and up-to-the-moment picture of the movement of storm centres and areas of precipitation over ranges up to 200 n. miles. Remote displays, static or mobile versions are available.



TYPE S264

TYPE S 264 AIRFIELD CONTROL RADAR

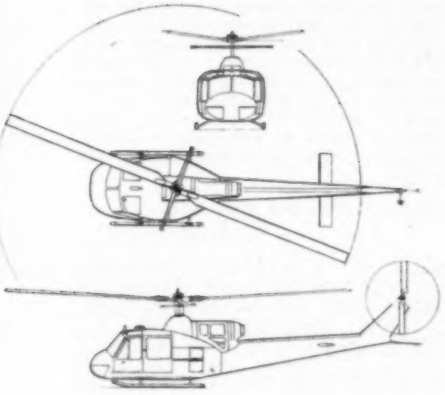
has been specifically designed for civil air traffic control and is not a modified military type. It operates at full efficiency in all weathers because the wavelength is long enough to penetrate cloud. Ground clutter which obscures aircraft response is removed by means of an extremely effective M.T.I., thus rendering identification procedure unnecessary. The equipment is instantly operational at its rated performance because it is crystal controlled and needs no adjustment after switching on. The S 264 is suitable for monitoring aircraft on airways at the approach to the control zone, controlling them in the stacks and feeding them on to ILS or PAR, providing limited P.P.I. controlled approach to runways and taking control of outbound aircraft as soon as they are airborne.

MARCONI

MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, CHELMSFORD, ESSEX, ENGLAND
R3

Above and below, Bell H-40.

Helicopters of the World . . .



stripe. The deluxe 47J Ranger offers a choice of five interior colour schemes with harmonizing exterior stripe. Overall exterior colour is maritime aluminium, interior upholstery includes carpeting, gabardine overhead, fabric covered foam rubber seat cushions trimmed with Naugahyde leatherette and fabric covered sound insulation on firewall and door panels. . . . Custom appointments are created by Horton and Horton, noted specialists in this field . . ."

● Rotor diam., 37ft 2in; length (main rotor blade extended), 42ft; empty weight, 1,538 lb; gross weight (standard configuration), 2,453 lb; max. speed, 105 m.p.h.; cruising speed, 98 m.p.h.; climb to 5,000ft, 3.8 min; absolute ceiling, 20,000ft; hovering ceiling in ground effect, 14,700ft; max. range, 216 miles.

H-40 This advanced helicopter bears the Bell model number 204. Several examples are flying on trials, and production aircraft will be delivered next year. The makers describe the aircraft in these terms: "Winner of an Army utility helicopter design competition, this single-rotor, turbine-powered craft can match the climbing performance of World War 2 fighters and the level-flight speed of many light airplanes. Designed for front-line service, the Bell helicopter is of low silhouette and compact configuration. It carries six persons and combines many engineering advances with time-tested control systems. Called the Iroquois by the Army, the H-40 is the first helicopter in service production to provide in-flight blade tracking and has all-metal rotor blades. The H-40 features quick, easy field maintenance and is the first helicopter designed for 1,000 hr of operation between major overhauls. Its Lycoming T53 engine was the first free-power turbine produced for helicopters and enables the H-40 to climb vertically at 1,900ft/min from sea level."

● Rotor diam., 44ft; overall length, 57ft; empty weight, 3,670 lb; gross weight, 5,620 lb; max. speed, 151 m.p.h.; range, 200 miles; hovering ceiling (without ground effect), 15,000ft approx.

XV-3 An experimental aircraft of exceptional interest, the XV-3 bears the Bell model number 200. A tilting-rotor convertiplane, it is powered by a Pratt and Whitney R-985 engine of 450 h.p. The twin three-bladed rotors are mounted near the tips of the relatively small wing, with the axes of the rotor masts vertical for "helicopter" operation. After a certain speed is reached the masts are tilted forwards through about 90 deg, so that the rotors are then acting as propellers. During conversion (which requires between 10 and 15 seconds) the lift load is transferred to the wing, and after conversion a transmission gear-change, similar to a car overdrive, is used to reduce rotor speed and thereby to attain improved high-speed performance. It is claimed that there will be no abrupt changes in flight characteristics during conversion and that the pilot will retain full control at all times. Not only is there no loss of height during conversion, but the operation can be performed while the aircraft is maintaining a steady climb. In case of engine failure, power-off conversion back to helicopter configuration can be made so that an autorotational landing is possible.

The latest information on the progress of the XV-3 was contained in a manufacturer's announcement last November, which reported that the aircraft had successfully completed full-scale wind-tunnel tests and was due to resume test flying during the following month. The announcement continued: "The convertiplane has been returned to the Bell plant [Fort Worth] following extensive testing through 90 deg conversions and all speed ranges in both airplane and helicopter configurations in the 40×80ft full-scale wind tunnel of the National Advisory Committee for Aeronautics Ames Laboratory, Moffett Field, Calif. The six-week wind-tunnel test program, during which 120 hours of powered tests were conducted, was established to check out the stability, control and vibration characteristics of the aircraft, equipped with the new two-bladed semi-rigid rotor system. Bell's chief experimental engineer said the system tests were satisfactory in every flight condition. The Ames tunnel tests simulated, as nearly as possible, actual flight conditions including several possible emergency situations. Conversion from helicopter to airplane configuration was explored both in continuous conversions and at fixed intermediate angles. Airplane operation throughout the speed range of the aircraft in both high and low gear ratios was investigated. Test speeds reached more than 170 m.p.h. Although the convertiplane was remotely controlled during the tests, Bell Helicopter test pilot Bill Quinlan was on hand to observe some of the more important phases. He is assigned to fly the XV-3 when test flights are resumed next month. Prior to modification of the rotor system the XV-3 had accumulated 14 hours of flight testing. Test flights have been performed with the rotor propellers tilted as much as 20 deg forward."

● Rotor diam., 25ft; length, 30ft; gross weight, 4,700 lb; max. speed over 170 m.p.h.; range, 480 miles.

Bensen Aircraft Corporation

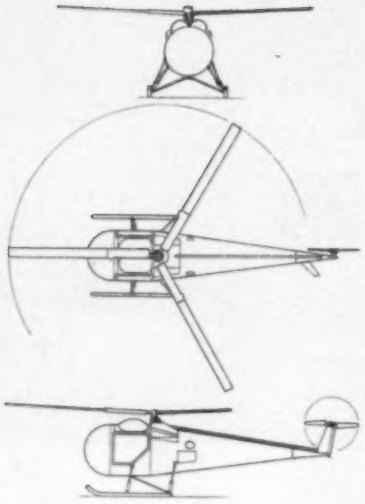
Raleigh-Durham Airport,
Raleigh, North Carolina.

B-7M Gyro-Copter The B-7M dates from late 1955 and was originally intended to be supplied in kit form for home construction. The engine is an air-cooled Nelson H-59A (four-cylinder, horizontally opposed two-stroke) of 42 h.p., driving a wooden propeller (the rotor is unpowered). A hanging-stick control lever operates in conjunction with the rudder pedals and a twist-grip throttle. The main structure is of aluminium tubing and the undercarriage is of nosewheel type. The makers list standard equipment as airspeed indicator, 1,000 lb safety belt, steel cable pull starter, six-volt battery, wheel-type landing gear and tow hitch; and optional equipment as altimeter, compass, shoulder harness, auxiliary fuel tank and float type landing gear.

● Rotor diam., 20ft; length (less rotor), 8ft 7in; empty weight, 180 lb; gross weight, 450 lb; max. speed, 75 m.p.h.; cruising speed, 60 m.p.h.; min. level speed, 15 m.p.h.; take-off speed, 20 m.p.h.; landing speed, 7 m.p.h.; range, 100 miles; service ceiling, 12,500ft; max. rate of climb, 950ft/min. (Figures are based on preliminary measurements and are not guaranteed.)

B-8M Gyro-Copter The characteristics of this improved Gyro-Copter are seen in the photograph overleaf. The engine is a McCulloch 4318E four-cylinder two-stroke of 72 h.p.

● Rotor diam., 20ft; length (less rotor), 11ft 4in; empty weight, 250 lb; gross weight, 500 lb; max. speed, 85 m.p.h.; cruising speed, 60 m.p.h.; min. level speed, 14 m.p.h.; take-off speed, 18 m.p.h.; landing speed, 7 m.p.h.; range, 100 miles; service ceiling, 16,500ft; max. rate of climb, 2,000ft/min. (Figures are based on preliminary measurements and are not guaranteed.)



Above, Bensen B-8M. Right, Brantly B-2.

Helicopters of the World . . .

Brantly Helicopter Corporation

24 Maplewood Avenue, Philadelphia 44, Pa.

B-2 The Brantly B-2 is a two-seater helicopter of notably clean design. The main rotor has three all-metal blades, with conventional flapping hinges and pitch change bearings at the rotor head. In addition, extra flapping hinges and lag hinges are located approximately 40 per cent of the distance from the rotor head to the blade tips. Provision of the extra flapping hinge and offsetting of the lag hinge are stated to be among the most important design innovations in the Brantly rotor system. The blade sections inboard of the lag hinges are of greater chord and incidence setting than the outboard sections, providing effective twist and taper. The blades are unusually heavy, and besides providing a good margin of "flare power" by storing kinetic energy for power-off landings, the blade weight is claimed to help to maintain concentricity of the mass in forward flight.

The transmission is a planetary-gear type, designed to operate at low tooth pressures and to reduce radial loads. It operates with splash lubrication, and without the need for external oil cooling. The clutch is engaged by centrifugal action and 96 small steel balls and is self-adjusting. The Lycoming engine is a Model VO-360 A1A, modified for vertical operation and rated at 170 h.p. Cooling air is drawn across the cylinders by a pressure drop created by the velocity of exhaust gases.

● Rotor diam., 23ft 8½in; fuselage length, 21ft 4in; empty weight, 960 lb; gross weight, 1,600 lb; cruising speed, 100 m.p.h. approx.; max. speed, 120 m.p.h. approx.; sea level rate of climb, 1,330ft/min.

B-3 This will be a twin-engined tandem-rotor helicopter using, with little or no change, the engines, transmissions and rotors developed and tested in the B-2. The cabin will accommodate four stretchers and will have a floor hatch for rescue operations.

● Rotor diam., 23ft 8½in; empty weight, 2,000 lb; gross weight, 3,400 lb; cruising speed, 100 m.p.h.

B-4 The makers state that as soon as development work is complete on the B-3 they plan to proceed with a machine of the same configuration but much larger, having four engines (two forward and two aft) and seating about 50 passengers. This machine should be capable of cruising at full gross weight with three engines operating.

The Cessna Aircraft Company

Wichita, Kansas.

YH-41 Known to the U.S. Army as the Seneca, the YH-41 is a four-seater utility helicopter powered by a 270-h.p. FSO-526A Continental supercharged engine. Metal construction is used throughout. The primary structure of the main part of the fuselage is a double-skinned platform, the top of which serves as the floor for the cabin. This section houses the fuel cells and the lower control assemblies, and supports the main rotor transmission, the engine mounting and the landing gear. The support structure for the wind shield and windows also serves as a structural tie between the front and rear parts of the fuselage. The two main-rotor blades are attached to the hubs by flexible L-section hinges of steel sheet, permitting continuously varying pitch of the blades without recourse to pitch-change bearings. The attaching members are made from four sheets of stainless steel formed into L-shaped angles and nested one above the other. Forward mounting of the engine allows a 360 deg field of view for the passenger compartment, which seats four people. Alternatively, the YH-41 can carry pilot and passenger and over 500 lb of freight for ranges up to 100 miles; two stretcher patients and an attendant are another optional load. The skid-type undercarriage uses stainless-steel tension straps in the attaching structure. On normal landings the action is very stiff but on hard landings the excess energy is absorbed by plastic deformation of the stainless-steel straps. Stretching of the links gives a new angular position to the landing gear struts but does not otherwise affect operation. The tension straps can be used until successive hard landings displace the gear to the point of introducing ground-clearance problems. Clip-on wheels are provided for ground handling.

● Rotor diam., 35ft; fuselage length, 32ft 1in; empty weight, 2,017 lb; gross weight, 3,000 lb; max. speed 124 m.p.h.; service ceiling at 3,000 lb weight, 16,000ft; max. range, 222 n.m.

Convertawings, Inc.

Zahns Airport, Amityville, N.Y.

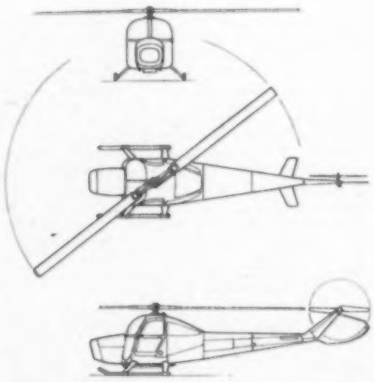
Model A Quadrotor The makers claim for this flying test-bed that its successful performance has "provided conclusive proof that the Quadrotor configuration, using a simplified rotor and control system in a compact design, is workable, and provides the means for a basic improvement in the helicopter." They add that control is obtained by a differential thrust between the rotors. Complete elimination of cyclic-pitch control and rotor hinge mechanisms is said to produce powerful damped control about all axes. The four-rotor configuration is claimed to confer weight saving, good handling qualities, safer control, reduced vulnerability, drive simplification and compactness. It is also claimed that it provides naturally for multiple pod-mounted powerplants and auxiliary aerofoils without adding structure. The airframe can be economically constructed and maintained by utilizing small duplicate, constant-section components. The identical blades are only one-half as long as on an equivalent single rotor; blade droop is reduced by over 65 per cent, with a corresponding reduction in necessary height and ground-handling problems. The fuselage is free of powerplants, improving safety and comfort, and allowing flexible use of its full volume.

Projected Convertiplane Convertawings plan to develop a transport convertiplane seating 15-20 passengers and powered by Allison T38s, and work is in hand on a small two-seater prototype to prove the configuration and control system. The prototype will have two Boeing 502 gas turbines, giving a top speed of 260 m.p.h. Conversion will be accomplished by tilting the wing and rotor assembly, and running take-offs and landings will be possible if increased range is required. A forced landing could be made with the aircraft gliding.

Doak Aircraft Co. Inc.

22309 Western Avenue, Torrance, Calif.

Model 16 This extremely interesting research vehicle has already made its first tethered flight. Designed by Doak for the U.S. Army Transportation Research and Engineering Command, it has ducted propellers at the wing-tips which rotate through 90 deg to convert in flight from



Above and below, Cessna YH-41.

vertical take-off and hovering to normal flight. Power is provided by a Lycoming T53 shaft turbine. It is stated that the entire aircraft remains in a conventional horizontal attitude at all times during transition. The makers state: "Where airfields are available, the Doak 16 will take off and land horizontally as a conventional aircraft. Then it can carry extra fuel tanks and therefore travel even greater distances, since horizontal take-off requires less power and enables the airplane to lift more weight. The Army sees the Doak 16 VTOL as a bridge between the helicopter and the airplane, combining the best features of both. For reconnaissance, liaison and rescue missions the Doak 16 will travel farther and faster than the helicopter and therefore need not be stationed nearby or be transported to within short operating distance. Although the Doak 16 is being developed for the U.S. Army, its design originated from research in ducted propellers for vertical flight privately financed by Edmond R. Doak and the Doak Aircraft Company, Inc., over a period of twenty years. It has more than military significance, according to Mr. Doak, who stated: 'Ducted propelled aircraft of this type, with vertical take-off and landing, long range, and high speed, can provide the commercial feeder line service needed to carry traffic between the few major landing fields along the paths of the big, non-stop airliners and the many, smaller, outlying cities having no huge, jet-age airports'."

Left, Goodyear GA-400R Gizmo. Right, Gyrodyne XRON-1 Rotorcycle.

Doman Helicopters, Inc.

Danbury, Connecticut.

LZ-5-2 Bearing the U.S. Army designation YH-31, the LZ-5-2 is an eight-seater single-rotor helicopter with some uncommon features, of which the rotor system is the most notable. The makers describe the rotor in the following terms: "Its mechanical design is completely original; its kinetic and aerodynamic design are as advanced as any rotor system that has been proposed in the world to date. Mechanically, the rotor has hingeless blade mounts. The entire blade attachment, hub tilting mechanism, controls and transmission drive are completely enclosed, sealed from dust, dirt and water and automatically lubricated with a pressure oil system. The tail rotor is of similar construction with equal advantages. The hingeless hub is mounted on a freely tilting universal or gimbal which does not rotate and is attached to the non-rotating pylon. The fact that the tilting gimbal itself does not rotate is a major departure in the Doman concept. The drive shaft from the primary transmission passes through the centre of the rotor (carrying none of the lifting load) and a universal joint permits it to follow the tilting hub. It then passes into a planetary reduction transmission on top of the hub which allows the shaft to run at substantially higher than rotor speed. Although this particular feature of the high-speed shaft is optional, it will probably be used on all larger Doman rotor heads.

The welded steel tube fuselage is covered with magnesium alloy sheet, and the Lycoming SO-580-A1B engine is installed in the nose. Most of the skinning of the aircraft is non-structural and may be easily removed to convert to the stripped configuration for greater payload, repair or refinishing. The ability to utilize the stripped configuration is valuable for cargo operation since it increases the payload by approximately 20 per cent. For shipping or crating, the fuselage may be readily disassembled into smaller components. The cabin is easily converted from cargo to passenger use in a matter of minutes, and there is a very large window by each seat.

● Rotor diam., 48ft; fuselage length, 38ft; empty weight, 3,250 lb; gross weight, 5,200 lb; max. continuous speed, 100 m.p.h.; speed for best range, 81 m.p.h.; range (standard tanks), 486 miles.

The Goodyear Aircraft Corporation

Akron 15, Ohio.

GA-400R Gizmo The Gizmo is an ultra-light single-seat helicopter designed to serve as "either a courier-liaison or tactical vehicle," and developed primarily for any purpose requiring the transportation of one man up to 60 kt. The airframe is of welded tubing and is supported by steel outrigger tubes on the undercarriage skids, which are of aluminium. Power is supplied by a production water-cooled, two-stroke engine which drives the rotor through a belt and pulley arrangement. The makers state that the aircraft is capable of "hovering manœuvres, pattern flight, steep turns, high speed, forward flight, rolling pull-outs, and other similar functions."

● Rotor diam., 20ft; empty weight, 275 lb; gross weight, 475 lb; max. speed, 60 m.p.h.; cruising speed, 46 m.p.h. approx.; range, 50 miles approx.

Gluhareff Helicopter Corporation

Manhattan Beach, Calif.

Meg-2 The Meg-2 is a strap-on helicopter and is described as the smallest jet helicopter in the world. It has pressure-jets located at each blade tip and developing 17 lb of thrust apiece. The aircraft is said to be able to operate "on cheap propane gas and three flashlight batteries." Flight tests have been conducted with the device attached to a safety wire.

● Rotor diam., 20ft; empty weight, 68 lb; gross weight, 293 lb; max. speed, 50 m.p.h. approx.; cruising speed, 40 m.p.h. approx.; range, 25 miles approx.; hovering ceiling, 4,500ft.

Gyrodyne Company of America, Inc.

Flowerfield, St. James, Long Island, New York.

XRON-1 Rotorcycle This tiny helicopter is being developed under U.S. Navy contract and is seen in its latest form in the accompanying photograph. Although to date strictly a military project, the makers intend eventually to certificate the machine with a view to marketing a civilian version. Of co-axial configuration, the Rotorcycle is powered by a Porsche 1,600 cc car-type engine but this will eventually be replaced by a Porsche specifically designed for the installation.

● Rotor diam., 17ft; fuselage length, 11ft; empty weight, 381 lb; gross weight, 645 lb; max. speed, 72 m.p.h.; cruising speed, 52 m.p.h.; max. rate of climb at s.l., 945ft/min.; service ceiling, 10,400ft; vertical rate of climb at s.l., 500ft/min; hovering ceiling out of ground effect, 2,800ft; normal range, 23 n.m.

Below, Doman LZ-5-2.

Doak Model 16

Helicopters of the World . . .

Hiller Helicopters

Palo Alto, California.

H-23C Production of this model for both U.S. Army and Navy began in 1955, and many H-23Cs are used for training at Camp Wolters, Texas. The U.S. Navy version is designated HTE-2. The civil equivalent, which is in world-wide service, is the 12C. Accommodation is for three people, and the single two-bladed rotor has the Hiller "Rotormatic" cyclic-pitch control affording very good stability. Recent 12Cs are powered by the Franklin 6V-335-B giving 210 h.p. Military H-23Cs still have the Franklin 6V4-200-C33 giving 200 h.p.

● Rotor diam., 35ft; length (over rotors), 40ft 6in; empty weight, 1,737 lb; gross weight, 2,500 lb; max. speed at sea level, 87 m.p.h.; cruising speed, 71 m.p.h.; cruising range, 104 miles; service ceiling, 10,500ft.

H-23D This is the latest military version, powered by a Lycoming VO-435-A1C giving 250 h.p. The complete transmission system has been specifically designed for an overhaul life of 1,000 hr. Deliveries began last December. Accommodation for three and general layout are unchanged.

● Rotor diam., 35ft; empty weight, 1,780 lb; gross weight, 2,700 lb; max. speed, 95 m.p.h.; cruising speed, 82 m.p.h.; cruising range, 205 miles; hovering ceiling (in ground effect), 5,200ft; service ceiling, 13,200ft.

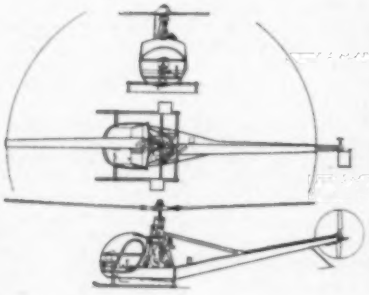
Hiller VZ-1E.

H-32 At least eleven H-32s have been delivered to Fort Rucker, Alabama, for U.S. Army tests of tip-propelled helicopters, but no production order has been placed. The H-32 is a two-seat machine, developed from the Hornet of 1950, with two-bladed rotor powered by two 8RJ2B ramjets delivering about 45 h.p. each for a weight of 13 lb each. An anti-torque tail-rotor and horizontal stabilizers are fitted. Hiller are also working on the adaptation of turbojets to tip-drive. Advantages include simplification of drive system and reduction of mechanical complexity and cost. The fuselage is made of steel tubing and Fibreglas. The U.S. Navy has also received three machines designated HOE-1. The 8RJ2B is the only ramjet to have received C.A.A. certification.

● Rotor diam., 23ft 8in; length, 23ft; empty weight, 544 lb; gross weight, 1,080 lb; fuel capacity, 50 gal; cruising speed, 60 kt; rate of climb at sea level, 700ft/min; service ceiling, 6,900ft; endurance, 25 min.

Hiller YH-32.

Hiller 12C.



Hiller 12C.

XROE-1 Rotorcycle This remarkable light-weight machine is reported to have behaved very well in the flight tests completed last summer, though no production contract has yet been placed. Demonstrations and exhibitions on a world-wide scale are being prepared for both military and civil purposes. It has a single two-bladed rotor and anti-torque rotor powered by a Nelson H-59 two-stroke, four-cylinder engine giving 40 h.p.; and it can be rapidly dismantled and folded for stowage or for para-dropping in a container 14ft long and 27in wide. It was designed for the U.S. Marine Corps under Navy contract, although the Army has shown interest. The rotor, with its stabilizing paddles, and the tail rotor can be quickly adjusted to give required responses for training or operational tasks.

● Rotor diam., 18ft 6in; max. length, 16ft 6in; height, 7ft 5in; empty weight, 270 lb; gross weight (including 60 lb of miscellaneous equipment), 526 lb; max. speed, 70 m.p.h.; cruising speed, 52 m.p.h.; cruising range, 27 miles; hovering ceiling (out of ground effect), 4,700ft; max. rate of climb at sea level, 1,130ft/min; fuel/oil mixture capacity, 2.5 gal.

VZ-1E Flying Platform The company built and flew the first flying platform in 1955, but are now making the three-engined VZ-1E platform for the U.S. Army as a ducted fan prototype. Larger and more elaborate versions are foreseen. The platform in its present version consists of a ducted fan of 8ft diameter driven by three four-cylinder outboard engines delivering 44 h.p. each. One man is carried standing on a small platform and control is by shifting the man's weight in direction of desired translation. Some stabilizing controls are presumed to be fitted; and the two prototype machines have four adjustable vanes in the efflux for this purpose. Further developments in twin-fan platforms and flying cranes are projected.

● Fan duct diam., 8ft; no other figures have been released.

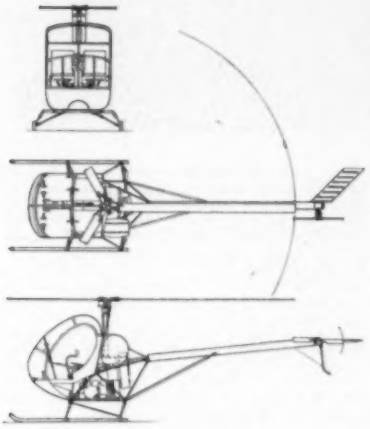
X-18 Tilt Wing Free-flight tests of a 6ft-span model of the Hiller tilt wing project have been completed at the NACA Langley Field Laboratory, including hovering and conversions. Results are reported to have been good. Construction of the full-scale aircraft, based on a Chase C-122 fuselage, is nearing completion and full tests might begin this year. Two Allison T40 turboprops with contraprops will provide power, together with a pair of steering engines in the tail. The wing will tilt between the vertical and flying incidence; and the fuselage will provide sufficient space for a full test crew. The X-18 is under development for Air Research and Development Command of U.S.A.F. No further details have been released.

Hiller XROE-1.

Hiller X-18.

Above and below, Hughes Model 269A.

Kaman HU2K-1



Hughes Tool Company, Aircraft Division

Culver City, Calif.

Model 269A The Model 269A is a development of the 269, simplified and cleaned up in several respects. It is a two-seater, ultra-light helicopter with a three-blade main rotor, the blades being of metal construction. A Lycoming O-360 engine is installed and has been derated from 180 h.p. to 160 h.p. for this particular application. There is a neat Plexiglas canopy for the pilot and passenger and dual controls are optional. The 269A is being developed to meet a military requirement, but the makers state that the appeal for a simple, economical, high-performance helicopter in a price class roughly half that of present helicopters has "stimulated a lively interest in civil circles."

● Rotor diam., 25ft; empty weight, 890 lb; gross weight, 1,550 lb; max. speed, 90 m.p.h.; cruising speed, 75 m.p.h.; range at cruising speed, 150 miles; max. rate of climb, 1,100ft/min; vertical rate of climb, 400ft/min.

Miscellaneous Hughes Projects The Aircraft Division of the Hughes Tool Company is actively engaged in all phases of heavy-lift helicopter research and development and has operated a research vehicle of the pressure-jet rotor type (XH-17), which has been flown at gross weights of 46,000 lb. Design work has been undertaken on other large pressure-jet studies.

Kaman Aircraft Corp.

Bloomfield, Conn.

HOK-1 This twin-rotor helicopter bears the makers' designation K-600 and continues in production for the U.S. Navy and Marine Corps. It has twin two-blade intermeshing rotors and twin tail-booms. The engine is a Pratt and Whitney R-1340-28 of 600 h.p., mounted at the rear end of the fuselage at an angle of 35 deg. Blade pitch is controlled by servo flaps. In U.S. Marine Corps service HOK-1s are intended for cargo carrying, casualty evacuation, search and rescue, reconnaissance and personnel transport. Normally seats for four are provided.

The HUK-1 is a "utility" Navy version. A similar machine is the H-43, being ordered in large numbers as the standard fire/crash-rescue helicopter of the U.S.A.F. The H-43A has an R-1340 engine; the H-43B is turbine-driven (picture below).

● Rotor diam., 47ft; max. length, 47ft; gross weight, 5,800 lb (normal); gross weight, 6,800 lb (max.); max. speed, 110 m.p.h.; hovering ceiling in ground effect, 12,000ft; normal still-air range, 220 miles.

HU2K-1 The photograph on this page depicting the forthcoming HU2K-1 utility helicopter shows the very elaborate mock-up which has been constructed for the U.S. Navy. Kaman have received a Navy contract to produce "a prototype quantity" of HU2K-1s powered by the General Electric T58 gas turbine. Features of the HU2K-1 include four-blade main rotor equipped with Kaman "servo flap" control system and a retractable undercarriage.

Kellett Aircraft Corp.

P.O. Box 35, Willow Grove, Pennsylvania.

KH-15 This research helicopter dates from 1954 and is described as a variable-stability test-bed. It is powered by two Reaction Motors XLR32 hydrogen peroxide rocket motors, mounted at the tips of the two-blade rotor. Its principal function, however, is to flight-test a gyro-stabilizing system and to demonstrate positive dynamic stability without loss of control throughout the speed range.

● Rotor diam., 18ft; empty weight, 264 lb; gross weight, 610 lb.

K-25 The K-25 is a projected convertiplane powered with a Lycoming XT53-L-1 gas turbine. The two rotors measure 32ft 6in diameter and the undercarriage is retractable. (Drawing below.)

Laskowitz Helicopter Co.

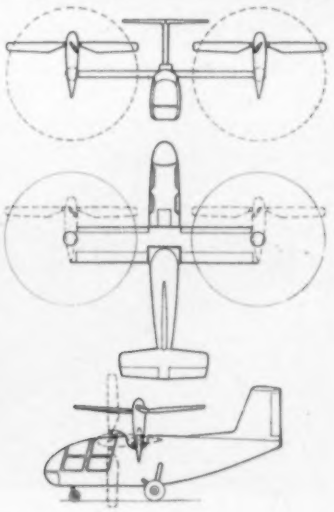
Projected Convertibles One Laskowitz project—the L15CV—is designed for a Continental Palas turbine and will have a two-blade rotor. A two-seater, this machine will have a maximum speed of 215 m.p.h. and a range of about 170 miles. The Model L180CV-1 is a larger machine with two Westinghouse J34 turbojets. The two-blade rotor has a diameter of 104ft and weight empty is given as 11,970 lb. Up to 21 passengers could be carried, and the maximum speed is estimated as 450 m.p.h. Range is stated to be 270 miles.

McDonnell Aircraft Corp.

St. Louis 3, Missouri.

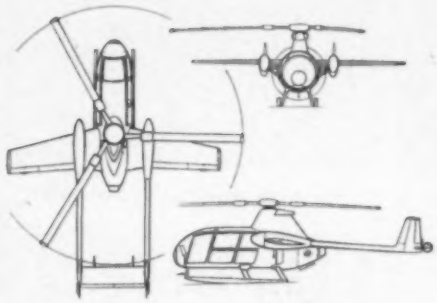
XV-1 Bearing the makers' works designation Model 82, this experimental convertiplane is being jointly developed by the U.S.A.F., the U.S. Army and the McDonnell Aircraft Corporation. A speed of 200 m.p.h. has been achieved by one of the two prototypes built. The rotor is driven by

Below, Kaman H-43B (Lycoming T53 development of HOK-1); right, Kellett K-25.



Rotorcraft RH-1 Pinwheel.

Omega BS-12.



McDonnell XV-1.

Helicopters of the World . . .

McDonnell-developed pressure-jets at the tip of each of the three blades. The pusher propeller is powered by a Continental R-975-19 piston engine, which also drives compressors for the supply of air to the pressure jets during "helicopter" flight. The machine carries three passengers or two stretcher patients and a medical attendant in addition to the pilot. The pilot and co-pilot/observer sit in tandem and dual controls can be fitted. The exit doors are jettisonable. A tailplane carrying tabs is mounted between the two tail booms. Two non-retracting skids comprise the landing gear, and the installation is unusual in that energy is absorbed during a hard landing by yielding, replaceable, stainless-steel straps.

● Rotor diam., 31ft; overall length, 31ft; empty weight, 4,277 lb; gross weight, 5,505 lb; hovering ceiling in ground effect, 7,500ft; normal range, 300 miles.

Nagler Helicopter Co., Inc.

Westchester County Airport, White Plains, N.Y.

NH-160 This is a single-seat ultra-light test-bed with coaxial rotors driven by a McCulloch 4318 engine of about 70 h.p. An unorthodox feature is the 6ft separation of the two rotors.

● Rotor diam., 20ft 3in; gross weight, 750 lb; max. speed, 90 m.p.h.; hovering ceiling in ground effect, 6,000ft.

Omega Aircraft Corporation

Municipal Airport, New Bedford, Mass.

BS-12 Progress with this interesting twin-engined helicopter is reported by Mr. B. W. Sznycer, president of the Omega Aircraft Corporation, in these terms:—

"From its beginning, the Omega engineering staff which for the first three years of operation consisted only of this writer, set itself an aim to design and construct a prototype helicopter, which though not constituting any major breakthrough in the art, would fulfil an existing need for a 'workhorse' type of a utility flying crane machine, the primary requisite of which (outside of safety) would be reliability, good payload and low initial price. It was this low initial price which dictated the size of organization and all the procedures which followed during the three years development programme.

"The basic policy of the design was avoiding an idea that helicopter economics are directly dependent on the ratio of payload to weight empty with little consideration given to the total cost of operation during the service life of the machine. Low development costs, due to the small size of the organization, is another item which should bring the cost of the machine to the level where a real market can be created. The extreme care which went into the design of the smallest component, and nearly absolute accessibility of every unit for inspection and replacement, has been proven already during the 250 hr testing time to which the aircraft was subjected during 1957.

"For the record, the helicopter left the shop at 1.32 p.m., 12/29/56, was flown the same day at 3.10 p.m., and has been flying ever since without any modifications or changes whatsoever. This total time included all the vibratory investigation of the engines and drive mechanisms, substantial amount of dynamic strain gauge testing, and two complete 100 hr tiedown tests, during which period a total of 154 hr full-throttle runs were made . . .

"The functioning of the two engines, driving one transmission through the system of V-belts proved extremely successful, resulting in a condition of the engines which was considered better than that of normal operational engines with the same time. The power splitting and synchronization does not require any skill, and numerous single-engine flights including landings were demonstrated. The control system proved positive but not nervous, and the aircraft can be flown with a certain amount of feel without artificial devices, or for that matter any hydraulic boosters, control loads being extremely light in all conditions of flight.

"Based on the results of tests to date and the good progress made toward C.A.A. certification, the initial production of 10 pilot aircraft has been started and is progressing satisfactorily. Needless to say, in the meantime, the staff of Omega has grown substantially . . ."

● Rotor diam., 39ft; overall length, 39ft 6in; empty weight, 3,125 lb; gross weight, 4,565 lb; best rate of climb, 950ft/min at 53 m.p.h.; max. speed, 92.5 m.p.h.; cruising speed, 75 m.p.h.; hovering ceiling in ground effect, 4,800ft; service ceiling, 12,400ft; absolute ceiling, 13,000ft.

BS-14 Falcon The first flight of this new helicopter is expected during the summer. It will be a two-seat single-engined type of extremely simple construction and good performance, intended for power-line patrol, fire reconnaissance and training.

● Rotor diam., 24ft; empty weight, 1,350 lb; gross weight, 2,000 lb.

Piasecki Aircraft Corporation

Island Road, International Airport, Phila. 42, Pa.

Type 59K A photograph on this page shows the mock-up of this most interesting VTOL project for the U.S. Army. Ground tests are stated to surpass the company's expectations. They were conducted on a full-scale, full-power test unit on a strain-gauged balance rig mounted on the bed of a large trailer truck, and were run to determine thrust efficiency, stability and control characteristics. The work has been completed to the satisfaction of the Army Transportation Research and Engineering Command, and two flying prototypes are under construction, well ahead of schedule. Ability to travel over any terrain, with or without roads, should render the 59K valuable as a light utility transport, observation platform or weapons carrier. Because of its shallow configuration it can hug the ground where concealment is desirable, and fly along small ravines, among trees or under bridges. The machine will be capable of flying high enough to fly over the mountainous territory in the United States, and forward speeds of over 150 m.p.h. are envisaged.

Piasecki Type 59-K.

Rotor-Craft Corporation

Glendale, California.

RH-1 Pinwheel The latest form of this single-seat ultra-light helicopter is shown in an accompanying photograph. The two-blade rotor is rocket-driven and the tail rotor is driven by belt. A hanging control is used for cyclic pitch.

● Rotor diam., 15ft; overall length, 7ft 6in; empty weight, 180 lb; gross weight, over 400 lb; max. speed, 80 m.p.h.; hovering ceiling in ground effect, 12,000ft; range, 30 miles.

Skyhook This forthcoming ultra-light helicopter attachment is said to weigh less than 75 lb and fit into an "oversize suitcase." Assembly time is stated to be two minutes, without tools.

(Above and right) Sikorsky S-56 (H-37)

Sikorsky Aircraft Division of United Aircraft Corporation

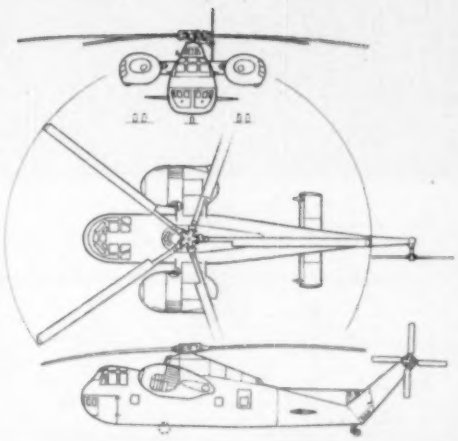
Bridgeport 1, Connecticut.

S-55 Since the first flight of the prototype S-55 in November 1949, this type has logged an impressive and ubiquitous record as a 12-seat utility helicopter, and is in use by Service and civil operators in many countries. Designated the H-19 by the U.S.A.F. and U.S. Army; the HO4S by the U.S. Navy and U.S. Coast Guard; and the HRS by the U.S. Marine Corps, the machine is usually powered either by a Pratt and Whitney R-1340 or a Wright R-1820. The following data apply to the S-55 powered by the R-1340:—

● Rotor diam., 53ft; fuselage length, 42ft 2in; empty weight, 4,920 lb; normal gross weight, 7,200 lb; max. speed at s.l., 101 m.p.h.; cruising speed, 85 m.p.h.; hovering ceiling with ground effect, 2,000ft; normal range, 400 miles.

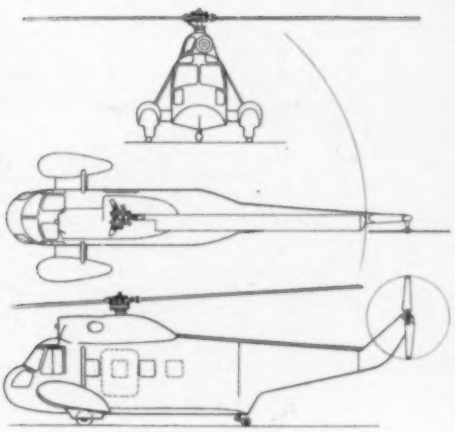
S-56 Designed as an assault helicopter to the requirements of the U.S. Marine Corps, this large twin-engined machine is operated by that Service as the HR2S, and by the U.S. Army (who are also purchasing the type) as the H-37. It is powered by two 2,000 h.p. Pratt and Whitney R-2800 Double Wasps, mounted outboard of the fuselage on stub wings, and was the first twin-engined helicopter to enter military service outside the Soviet Union. During intensive operational trials with the U.S. Marines last year a variety of heavy stores were carried (internally and externally), and up to 20 combat-equipped troops (maximum number of equipped troops is quoted as 26) per aircraft, in providing "vertical envelopment transport" for a Marine division. Price of the Army H-37 cargo carrier has been quoted as $950,000; and modifications suggested to improve the payload/range performance include the provisi. of a light, fixed undercarriage and the elimination of the clamshell doors in the nose.

A specialist HR2S variant is the Navy's HR2S-1W, which carries a large early-warning radar. Future developments of the type being studied by the U.S. Army include one powered by four 1,600 h.p. Lycoming T55 turbines, and one powered

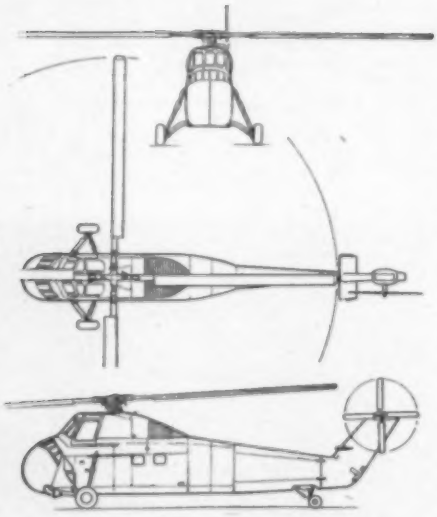


(Above) Sikorsky S-55.

(Above) Sikorsky S-60 crane project. (Below and lower right) Sikorsky S-62.



(Above and left) Sikorsky S-58.



Helicopters of the World . . .

by two General Electric J85s feeding air to pressure-jets at the blade tips.

● Rotor diam., 72ft; fuselage length, 82ft 10in; speed, 150-160 m.p.h.; gross weight, 26,000/30,000 lb; useful load, approximately 6,000 lb.

S-58 In production both for commercial operators and for the U.S. Army, Navy and Marine Corps (whose designations are H-34, HSS and HUS respectively), this type has been introduced as a larger and more powerful successor to the S-55. It is powered by a nose-mounted Wright single-row Cyclone C9 (similar to the military R-1820-84) which delivers 1,525 b.h.p. for take-off. Maximum cruise rating of the engine is 900 b.h.p. at 2,500 r.p.m.

The main rotor employs four fully articulated, all-metal blades which are completely interchangeable, and for which durability plus immunity from humidity and temperature extremes are claimed. The design incorporates the minimum number of parts in an endeavour to provide ease of assembly, long life and simplified maintenance. The four-bladed tail rotor is also of all-metal construction, and features a free-flapping mounting and servo-control.

Compared with the S-55, a reduction of 25 per cent in the number of main-transmission parts has been achieved. Transmission accessory drives are provided for the hoist, the primary servo-control hydraulic pumps, and the rotor tachometer, thus ensuring their operation during auto-rotative flight.

The fuselage is of conventional semi-monocoque construction, with non-structural clamshell doors giving good access to the engine and accessories. Structural provision is made for a 5,000 lb automatic touchdown-release cargo sling and a 600 lb hydraulic hoist. With normal load the range is 190 miles; an extra, under-floor fuel cell increases this to 293 miles, and by carrying extra fuel in the cabin a maximum range of 862 miles can be achieved.

● Rotor diam., 56ft; fuselage length, 46ft 9in (37ft with tail pylon folded); empty weight, 7,560 lb; gross weight, 12,700 lb; max. speed at s.l., 130 m.p.h.; cruising speed, 101 m.p.h.; hovering ceiling with ground effect, 4,500ft; normal range, 190 miles.

S-60 This design project, accorded until recently a relatively low priority in the Sikorsky programme, is for a "flying crane" helicopter which may be similar in appearance to the machine sketched on page 399. Following an increasing interest in the crane-helicopter concept, Mr. Igor Sikorsky has said that, if required, such a machine, using S-56 components, could be flying within a year. The first step would be to take advantage of the proven components of the S-56, and of the Pratt and Whitney R-2800s; while a later development would be to install turbine engines. This, it is reported, would increase the payload by about 1½tons.

The crane helicopter, as indicated in the sketch, will be much simpler in design than current cabin types. The machine will be essentially a structural body for carrying pilots, engines, rotors and hoists. Its military-transport possibilities are obvious and, if detachable pods are employed, wide commercial applications are envisaged.

S-61 Design features of this current Sikorsky project for the U.S. Navy include two turbine engines and a flying-boat hull with sponsons. It should be capable of remaining afloat for indefinite periods following emergency landings on water. The two engines, possibly General Electric T58s, are mounted above the 20-passenger cabin. Commercial applications, in particular for off-shore oil operators, are foreseen. The S-61's lifting ability should be very much greater than that of the S-58.

S-62 A combination of turbine power and well-proven S-55 components is the basis of the design of the S-62 (illustrated at the foot of the previous page) which is expected to fly this spring. The test programme should be complete this autumn, and deliveries are scheduled for one year later. Power is provided by a single General Electric T58 turboshaft engine of 1,024 h.p., while the proven components include all rotor blades; main and tail rotor heads; main, intermediate and tail gearboxes; shafting; tail rotor pylons; and portions of flight-control and hydraulic systems.

The machine is designed for amphibious operation without flotation gear. The lower fuselage is of flying-boat hull shape and is watertight, and it has been strengthened to permit the aircraft to make landings on either water or snow. The main wheels can be partially retracted in flight. Equipment which can be installed includes a 600 lb rescue hoist, an external 3,000 lb cargo sling, internal ferry tanks, and a 4,000 lb towing attachment.

Full power will be available up to 17,000ft. The empty weight of the S-62 will be 700 lb less than that of the S-55, and the extra power available for high-altitude or hot-weather flight is 230 h.p. Under all conditions, the payload will be approximately 700 lb greater than that of the S-55.

Helicopters of the World . . .

Transcendental Aircraft Corporation

Glen Riddle, Pennsylvania.

Model 2 The Transcendental Model 2 has a three-blade rotor attached at each end of its fixed high wing. These rotors can be tilted for horizontal or vertical flight. The engine is a Lycoming O-435-23 of 250 h.p., and provision is made for a crew of two.

● Rotor diam., 17ft; empty weight, 1,600 lb approx.; weight loaded, 2,250 lb approx.

Vertol Aircraft Corporation

Morton, Pennsylvania.

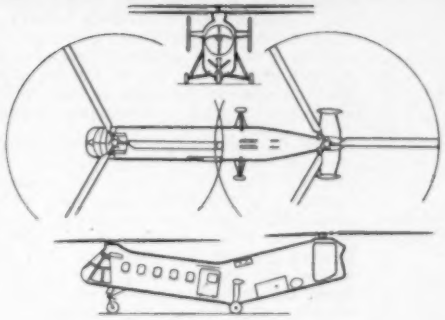
H-21 Designated by the U.S. Army as the Shawnee, the H-21 continues in production and has been developed into the Vertol Model 44 for civilian use. The Wright R-1820-103 piston engine is fitted. The H-21 is also widely used by the U.S.A.F.

In recent months work has been conducted by the U.S. Army in the arming of helicopters, and a standard H-21 has been equipped for laying down suppressive fire by installing a bracket on the undercarriage which carries two 0.30in and two 0.50in guns as well as several different rocket combinations. The initial installation mounted eight 3.75in Oerlikon rockets; a later installation substituted two rocket pods, each containing seven 2.5in rockets. In addition, this aircraft was also equipped with an easily removable 0.30in gun mounted in the main cabin doorway, and reinforced rifle ports for each of the cabin windows.

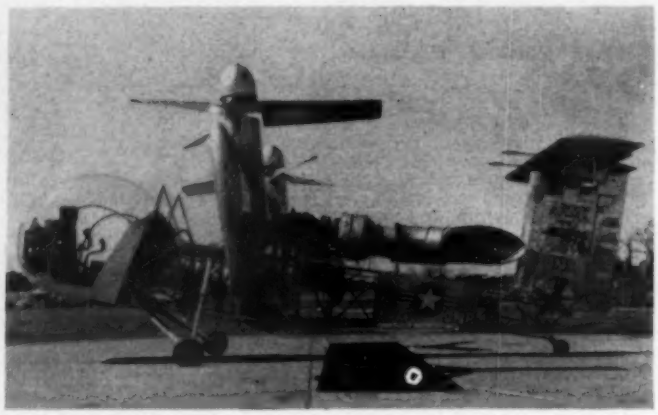
● Rotor diam., 44ft; overall length, 86ft 4in; empty weight, 8,600 lb; normal gross weight, 13,300 lb; max. gross weight, 15,000 lb; max. speed, 140 m.p.h.; hovering ceiling in ground effect, 6,100ft; normal range, 400 miles.

H-21 (Turbine Developments) Two H-21s have been modified for turbine power. One, known as the H-21D, is a standard Army helicopter having two General Electric T58 turboshaft engines and has been developed under contract with the U.S. Army and the Navy Bureau of Aeronautics. The second, called the Vertol 105, has two Lycoming T53 turboshaft engines, and is owned by the Vertol Aircraft Corporation itself. Vertol's vice president is on record as saying that the twin turbines give the H-21 a 40 per cent increase in payload and an increase in speed of 50 m.p.h. This means, he said, that the aircraft could do twice as much work in a given period of time. The engine installation in the Model

Vertol H-21.



(Below and right) Vertol 44.



Vertol 76 (in extreme configurations).

Helicopters of the World . . .

105 has been designed as a kit so that the twin turbines can replace the single piston engine in existing H-21s with only minor modifications to the airframe, and using the same engine-mounting attachments. This is considered by the company to be a simple and comparatively inexpensive way for either military or commercial customers to increase greatly the utility of their aircraft and extend their life. Vertol is prepared to offer turbine kits designed around either the General Electric or Lycoming engines.

Model 44 Essentially the Model 44 is an improved H-21. Three versions are offered: the 44A with a utility/cargo interior, including provision for troop seats, stretchers, cargo tie-downs, rescue hoist, and a cargo sling; the 44B with a finished interior and passenger seats for airline and commercial charter applications; and the 44C for business or private owners, with luxury appointments designed to the purchaser's custom requirements.

The all-metal fuselage is of stressed skin, semi-monocoque construction, and incorporates a cantilevered cockpit in the nose with a generous area of transparent panels. Immediately aft of the two-seat cockpit is a cabin compartment 20ft long, with direct access between the two compartments. The main entrance door is on the left side of the fuselage at the aft end of the cabin and an additional access (or emergency) door is provided at the forward end on the right side just aft of the cockpit. The fuel tank, with a capacity of 300 U.S. gal, is located aft of the cabin compartment, and is separated from the engine compartment by a stainless steel bulkhead. The engine compartment is located aft of the fuel tank. In the forward portion is a 50 cu ft baggage and mail compartment with an external access door. Immediately aft of this is the engine; readily removable structural doors and a removable structural section of keel are provided to permit lowering the entire powerplant package as a unit for periodic overhaul.

The 9-cylinder Wright Cyclone radial engine (U.S.A.F. designation R-1820-103), which develops 1,425 h.p. for take-off, is mounted with the drive shaft horizontal and projecting forward. A fan mounted on the forward side of the engine draws in air for cooling purposes through openings in the dorsal fin. The air is directed over the cylinders of the engine and is discharged through two circular openings in the bottom of the fuselage near the tail. Engine torque is transmitted to the rotors through a clutch assembly to a central transmission located amidships, and thence, by means of drive shafting, to reduction transmissions located below each rotor hub.

All flight controls are hydraulically actuated. There are no large unbalanced forces present in the controls, even with the hydraulic system inoperative, thereby making it possible for the pilot to fly manually with the boost off for extended periods without undue fatigue.

● Rotor diam., 44ft; overall length, 86ft 4in; empty weight (44B), 9,523 lb; gross weight (44B), 14,000 lb; max. speed, 126 m.p.h.; cruising speed, 101 m.p.h.; max. rate of climb at s.l., 1,050ft; hovering ceiling in ground effect, 5,000ft; hovering ceiling out of ground effect, 3,500ft; range (with reserves), 315 n.m.; service ceiling, 10,600ft.

New Vertol Type A new turbine-powered transport helicopter is being developed from the Vertol 44. More passengers will be accommodated.

Vertol 76 The foregoing is the company's designation of a tilt-wing VTOL research aircraft sponsored by the U.S. Army and developed in co-operation with the Office of Naval Research. The wing, and two counter-rotating propellers, are tilted as a unit through a 90 deg arc and may be moved to any angle between two extremes for short take-off or landing. Two ducted fans in the tail provide additional control in hovering. The powerplant is a Lycoming T53. Pictures appear above.

Williams

Dallas, Texas.

Convertiplane This is a home-built convertiplane by J. R. Williams for which a maiden flight is planned in the spring. Little is known of the aircraft beyond what is seen in the accompanying photograph of the skeleton.

Williams Convertiplane.

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AE27a

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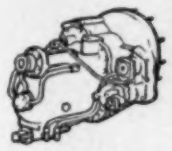

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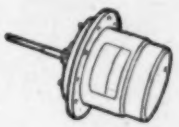

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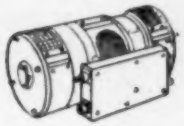
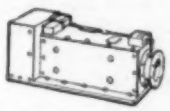


Invertors

Alternators



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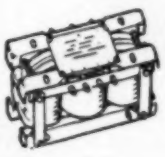

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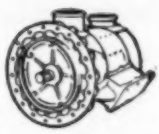

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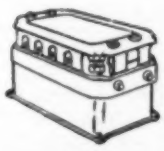
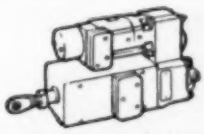


Circuit Breakers



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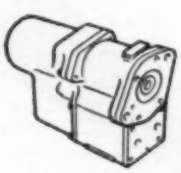
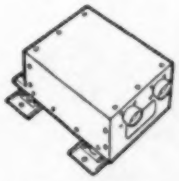


Rotary Actuators



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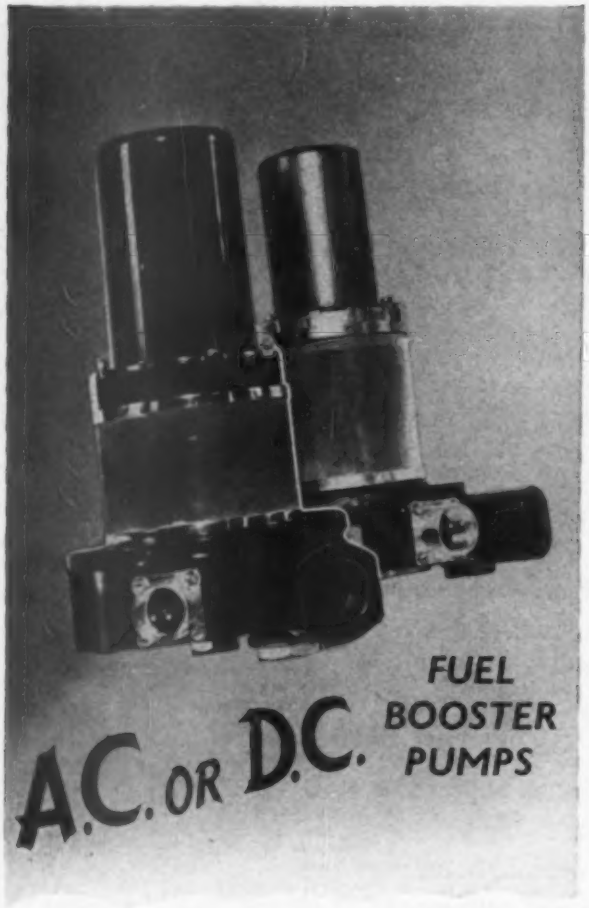

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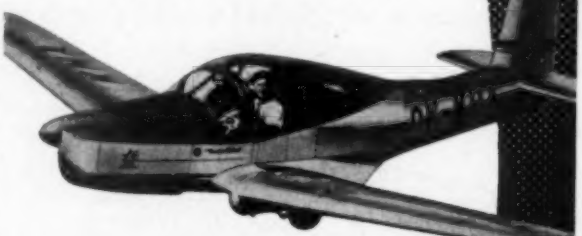

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Straight and Level

THE journal of the British Air Line Pilots Association, *The Log*, complains about the way airline crews are "subjected to the rigours of a Press conference" after an accident.

Why cannot the crews concerned just refuse point-blank to give a Press conference?

I am, incidentally, interested to see that *The Log* takes up the cudgels (which I wielded a few weeks ago) about rearward-facing seats. After airing the pros and cons, "Aerius" says: "Let B.A.L.P.A. insist that the rearward-facing seat be made mandatory next year in all aircraft in which it can sensibly be fitted."

● Working himself out of a job has always been the spectre haunting the good old British employee. Only the other day I read of trouble in a drawing office because a firm introduced a powered pencil-sharpener, which doubtless threatened the livelihood of thousands.

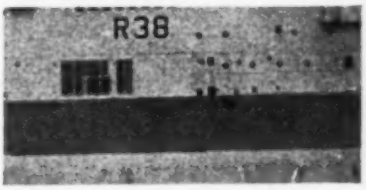
Somehow the world's airline aircrew unions seem to have missed out in the great crusade to keep their members employed. If one accepts the venerable Handley Page 42 (Western route configuration) as a good basic standard, it follows that, allowing for the same number of crew-members per unit of work performed (ton-miles per hour), the Boeing 707-428 as bought by B.O.A.C. should have 70.8 pilots, 35.4 radio officers and 70.8 stewards. This unfortunately just exceeds the total number of people for whom seats can be found on board.

● It is surprising how much you can usually improve an airframe if you really pay attention to detail. From the structural aspect the Comet 4 will probably always be regarded as a classic, while the Learstar forms an object-lesson in the reduction of drag. But one has to study the great Douglas family to see the process of evolution at its best. There is little doubt that, in the DC-7C, Douglas have almost reached the minimum drag for any practicable 139,000-lb piston-engined aircraft. In fact, its total equivalent drag at typical cruising conditions is the same as that of a 2¾-in-diameter rod, of length equal to the wing-span, pulled sideways through the air. All DC-7s are stressed for use of the main undercarriage units as air brakes at all speeds up to a 261 kt indicated speed limit. The equivalent flat-plate drag of these units comes to 27 sq ft—three square feet more than all the rest of the aircraft.

● Russians are usually good talkers. The other day I was passing the time of day with one, and I was mistaken enough to pull his leg a bit. "How," I said, "do you explain the fact that your aeroplanes are designated according to who led the design team? Didn't the Stalin cult of the individual receive the official phase-out?"

"Ah," came the reply, "if you take the trouble to think about it you will see that it is the logical way. All the earliest aeroplanes were known by who designed them. It was only when private companies were formed . . ."

● This photograph may stimulate the memories of many of my older readers. The letters are black, roughly 6ft high, and they are painted on a great grey British hull.



It is not what you thought, but a small bit of H.M.S. *Victorious*, the Royal Navy's most up-to-date carrier and the only one outside the U.S. Navy with a fully angled deck. The original R.38, the famous, ill-fated, airship, apparently never carried her designation at all, although I am open to correction.

As a matter of interest, *Victorious* could have carried the original R.38 quite neatly as deck cargo: her flight deck is 750ft by well over 100ft, and the airship measured 699ft overall by 85ft 6in diameter.

● Speaking before the U.S. Senate recently, Mr. T. G. Lanphier, a v-p. of Convair, said that emphasis on the anti (the anti-missile missile system) was far less than it ought to be and was only "1/150th of the effort" which Convair was directing on the Atlas ICBM.

People often say things like this, and I'm not sure quite what such statements mean. Presumably Mr. Lanphier was using as an index of emphasis the number of people working on the project . . . or the rate at which money was being injected . . . or square feet of plant area. Doubtless he would be perturbed to know that the emphasis being placed on Pan American's first interplanetary service is almost nothing: men and money only start to reach astronomical figures when the things they design attain the hardware stage.

● How narrow is the margin in aviation between disaster and success? One doesn't want to be morbid about this, but I doubt whether there is one successful managing director, be he manufacturer or operator, here or in America, who has not been badly disturbed at one time or another by a near-catastrophe. When disasters do strike, we should not be too hasty in finding cause for condemnation or reproof.

These recent words of an airline managing director perhaps best express what I am trying to say:—

"Safe flying is a combination of great care and good luck. The great care can be maintained but the good luck can run out. You know that some time an accident might happen after a long record of safety. Touch wood, cross your fingers, hope your hardest—and then it happens. . . ."

● One of the most respected captains of the British aircraft industry, Sir Roy Dobson, said something at the Avro 504 reunion (he is managing director of A. V. Roe) which made me think. He remarked, in so many words, that Britain should invest public money in the supersonic transport "in the interests of national prestige."

I feel sure Sir Roy will agree with me that prestige, like the accolade, is something you can't buy. Enduring prestige is the incidental result of producing sought-after aeroplanes, like DC-6s, Constellations, Viscounts or Hunters. Supersonic transports will, one of these days, be sought after; and if Britain has a good one to offer it will bring her prestige. Avro have the inside track in the supersonic-transport field; but I think that prestige may be an unsuitable pacemaker.

● There is no doubt that the nuclear-powered aeroplane poses some of the sternest design challenges which aircraft engineers have ever had to meet. In fact the U.S. Air Force, who know much, much more about this field than anybody else—for the simple reason that they have spent much more money on it than anybody else—have repeatedly stretched out their WS-125A nuclear bomber programme until some Senators, and possibly some people at Convair (Fort Worth) and Lockheed (Georgia), are wondering whether anything will ever get into the air at all. One thing seems pretty clear: the long-term job is the propulsion system, not the airframe; so I do not agree with the sages who seriously believe that America could fly a nuclear B-52 or P6M (or Princess) in a couple of years.

● "The Duke of Edinburgh . . . piloted his own aircraft to Wildenrath airfield and was 13 minutes late owing to bad visibility."—*Daily Telegraph*, March 12.

"Prince Philip, who was himself at the controls of the four-engined Heron, had made a slight detour because it was such a fine, sunny morning. He arrived 13 minutes late."—*Daily Mail*, same day.

ROGER BACON

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

R.A.F. Navigator Shortage

THE Air Minister has stated that the R.A.F. is having difficulty in recruiting sufficient navigators and that "this is worrying." At first sight this might appear to be a surprising state of affairs in view of the good status and pay accorded to navigators in the R.A.F. I suggest that a major reason for the shortage of navigators is this.

At the conclusion of his period of service in the R.A.F. the pilot, if he wishes to continue flying, can with reasonable certainty look forward to a highly paid career in civil aviation extending to the age of approximately fifty, followed by an adequate pension.

No such prospect is open to the navigator leaving the R.A.F. B.O.A.C. have recruited only one navigating officer in the last ten years and have followed a vacillating policy concerning the retention of those recruited in the 1945-47 period. The independents have a better record, but naturally their manpower requirements are small.

And, of course, the policy of the civil pilot's organization is now that of removing ultimately all other categories from the flight deck of civil aircraft.

The remedy for the R.A.F.'s shortage is obvious.

Edgware, Middx. E. P.

Prop-Jet with Jet Emphasis

WHAT a remarkable aircraft the Tu-114 is. In a flight of fancy I tried to account for its performance. Supposing such an aircraft could be fitted with a clutch and two position gear (engage or neutral) in the reduction gear assembly. The following possibilities seem to accrue:—

(1) Engage airscrews for take-off, giving shortest run and quietest operation for available e.h.p.

(2) Disengage airscrews and feather for optimum speed, altitude and economy, without facing the difficulty of supersonic airscrews.

(3) Engage airscrews for quiet, short landing, reverse airscrews on touching down. No thrust reversal problem here.

Are there any difficulties which would outweigh the more obvious advantages of such a system?

Hounslow, Middx. E. HALL.

Technicians' Status in America

YOUR correspondent P. R. Payne (January 24) has so confused and befuddled the subject under discussion that it is now more suited to the popular Press than to a technical publication. My remarks were clearly confined to office and personnel conditions only, as had been the previous correspondence on this subject, both from Britain and Canada.

The draft of my original letter (November 15) was shown to a number of my American office colleagues and they were asked to give their candid comments and to verify the statements I had made. Although they have, between them, experience in just about every American aircraft company all over the country, only one or two dissenting comments were made, and the draft was corrected to take care of them.

Mr. Payne's letter contains some very misleading statements, and in order to clarify them I find it distasteful, but necessary, to follow him out of the realm of aviation.

It will come as a great shock to the American inhabitants of the other 47 States to read his inference that California is the only norm by which to judge America and Americans. The term "New England" seems to have confused him, and if he had lived and worked in the North-Eastern section of the United States he would have realized that the inhabitants, conditions and ideologies are as 100 per cent here as those in California.

Mr. Payne was in Columbus, Ohio, for five days, yet he presumes to judge it and its people, and vows he would rather die than live there. This attitude reminds one of those North Americans—stock cartoon-and-joke figures—who "do" Europe in two weeks, and then consider themselves informed enough to proclaim on any European topic. Whilst it is true that I have lived in Montreal for 18 months and in only three of the Eastern States during the last five years, Mr. Payne during his 18 month stay has not lived beyond the confines of Southern Ontario, nor worked other than in a company which forms part of a British group. To form a reliable opinion of a people it is necessary not only to work with them, but also to live and work in the same way that they do, and in their surroundings.

In his reference to Montreal Mr. Payne shows that he has no first-hand knowledge of the city and its people. He has obviously listened to the Ontario politicians and Press statements that the French-speaking part of Canada is all things abhorrent, whereas I and almost all foreigners, British, American, European and Canadians from other provinces, have found life there to be most enjoyable with the bilingual French-speaking people who show more than warm hearts towards those who try to speak their tongue now and again. Having lived so congenially in Montreal, which to him is "more foreign than Paris, France," his reference to include me among his "malcontents and social misfits" is plainly humorous.

Finally, few people will agree with his philosophy "It is a good principle never to agitate for improvements, get out and go where the improvements exist." If mankind had always lived by this standard, time would have stood still and we would all have remained cavemen, for someone, somewhere, has to see the need for improvements before they can exist.

Newtown, Conn., U.S.A. EDMUND J. WEISS.

Idealism

I WOULD like to comment on Roger Bacon's statement in "Straight and Level" of your March 7 issue, in which he says that he is sure there is no place for idealists in the modern aircraft industry.

Aviation is such a fascinating subject that I am sure each issue of *Flight* could easily be ten times the size. It seems a pity, therefore, that valuable space should be wasted with meaningless, homespun philosophy.

If there had never been any idealists connected with aviation, there would never have been any aeroplanes and there will certainly be no more good ones unless quite a few idealists have quite a lot to say in the matter.

Any great man, whether he is in aviation, politics or the Arts must also be an idealist, otherwise he would not be great.

London, S.W.7. EDWARD LESLIE.

Unsung Heroes of 1914-18

I SEE Quentin Reynolds has written a book about combats of the air war of 1914-18. I hope this effort will inspire a British writer to give a detailed account of the 50 (or more) victories of Major L. G. Hawker, V.C., who was killed by Richthofen on November 23, 1916, when flying a de Havilland D.H.2 single-seater pusher fighter. Major Hawker's victories were all achieved without a synchronized machine gun and at a time when there were many peculiar types of German aircraft in small numbers flying along the Western Front.

I have often wondered why the air fights of Capt. A. W. Beauchamp-Procter, V.C. (54 victories), have never been fully described; and those of W/C. Raymond Collishaw (now A.V-M. retd.) who had 68 victories to his credit (perhaps he will oblige one day?).

Another not-so-famous fighter pilot of the 1914-18 war was W/C. Staton, who shot down 27 German aircraft while serving in the R.F.C. So far only a brief reference has been made to him, by Larry Forrester in his fine book *Fly for Your Life*, the story of W/C. R. S. Tuck, D.S.O., D.F.C. and two Bars. Perhaps Larry Forrester will write "Big Bill" Staton's story—I wish he would.

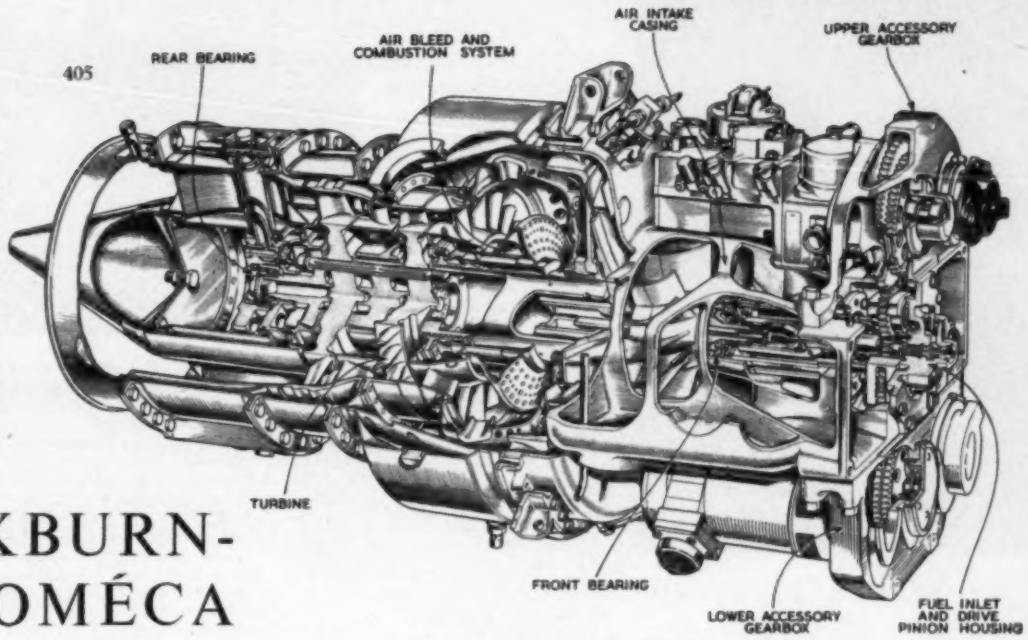
Birmingham, 14. MAURICE AUSTIN.

FORTHCOMING EVENTS

Mar. 21. Institute of Navigation: "The Effective Utilization of Airspace," by E. J. Dickie.
Mar. 24-27. Physical Society's Exhibition, Horticultural Halls, London.
Mar. 25. R.Ae.S.: Graduates' and Students' Section: A.G.M.
Mar. 27. R.Ae.S.: The Thirteenth British Commonwealth Lecture: "Why Airlines are Hard to Please," by B. S. Shenstone.
Mar. 27-28. Institution of Electrical Engineers: Radio and Telecommunications Section: Convention on Radio Navaids.
April 5. British Interplanetary Society: "Problems of Handling Large Missiles," by F. R. F. Taylor.
April 10. R.Ae.S.: Main Lecture: "Guided Weapons," by R. Cockburn.
April 11. Helicopter Association: "Powered Lift Systems," by Charles H. Zimmerman.

R.Ae.S. Branch Fixtures (to April 30)

Mar. 21, *Birmingham*, A Talk on Astronomy, by M. W. Ovenden. Mar. 25, *Luton*, A.G.M. and Presidential Address. Mar. 26, *Hatfield*, "Civil Airworthiness and the Air Registration Board," by R. E. Hardingham; *Preston*, "American Production Methods," by A. W. Turner. Mar. 27, *Bristol*, A.G.M. and Film Show; *Glasgow*, "Application of Electronic Control Techniques to Aircraft." April 1, *Boscombe Down*, "Aircraft Accident Investigation," by E. L. Ripley. April 2, *Weybridge*, "The Future of Nuclear Propulsion," by Rear-Admiral Sir Edward Rebbeck. April 16, *London Airport*, "Titanium," by H. W. Shaw; *Preston*, Annual General Meeting. April 23, *Leicester*, A.G.M. April 30, *Weybridge*, A.G.M.



This Blackburn cutaway drawing clarifies the principal mechanical details of the Palouste air compressor unit. Like other "first generation" Blackburn - Turboméca engines, it has a single-sided compressor driven by a two-stage turbine. A unique feature of the original French design is the truly annular combustion chamber, fed with fuel from radial holes in the main drive shaft to the compressor.

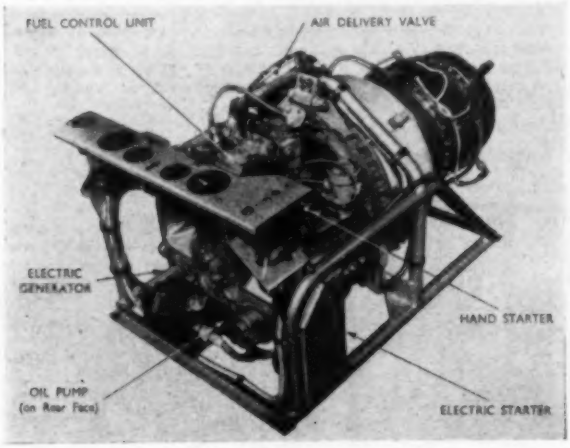
BLACKBURN-TURBOMÉCA

A Progress Report on an Integrated Range of Small Turbines

IN our issue of June 3, 1955, we published a comprehensive historical and technical survey of the development by the Engine Division of Blackburn and General Aircraft, Ltd., of Brough, East Yorkshire, of a range of inter-related gas turbine powerplants based on designs by the Société Turboméca of Bordes, France. Since that time the Blackburn-Turboméca family has been adversely affected by cancellations or reductions in British military helicopter orders; but, when viewed as a whole, remarkable progress has been made and commercial success can now be foreseen in an exceedingly diverse range of fields.

It may be remembered that the Blackburn family of small turbine engines originally stemmed from the French Palas turbojet. With suitable modifications, this unit forms the gas-generator portion for a variety of Blackburn turboshaft, free-turbine and air-compressor units. As we outlined in the issue already mentioned, Blackburn's acquisition of the Turboméca licence in October 1952 was the prelude to a lengthy period of basic redesign and improvement of the original French conceptions. Common components were evolved for a complete 400/450 h.p. range of engines (the Palouste, although employing similar parts, has a basic rating of some 350 h.p.); the front end was redesigned to incorporate ten accessory-drive pads and a bifurcated intake; and new materials, including Nimonic 90 turbine rotors and Nimonic 75 canware, were introduced to permit an increase in gas temperature and performance.

From the viewpoint of aircraft propulsion, the only unit of the range at present conducting much flying is the Palouste air-compressor, which powers the Fairey Ultra-Light helicopter. Development of this aircraft to full certification is proceeding as a private venture by Fairey Aviation; the Palouste powerplant has virtually completed its development and is proving a most reliable and satisfactory unit. Another helicopter flying on Blackburn turbine power is an experimental Kaman tip-drive machine in which a free-turbine Blackburn Turmo drives a Boeing compressor feeding air to the tips of the rotor bleeds. Twin Turmos are fitted to the hub-driven Kaman K-600 (HOK-1 derivative). Probably a much more important application of the Turmo is the new Saro 531 which is virtually a scaled-up Skeeter with five seats and a much higher performance. Saunders-Roe have been developing this helicopter with remarkable rapidity, and it is hoped to have an example flying at the S.B.A.C. display in September.



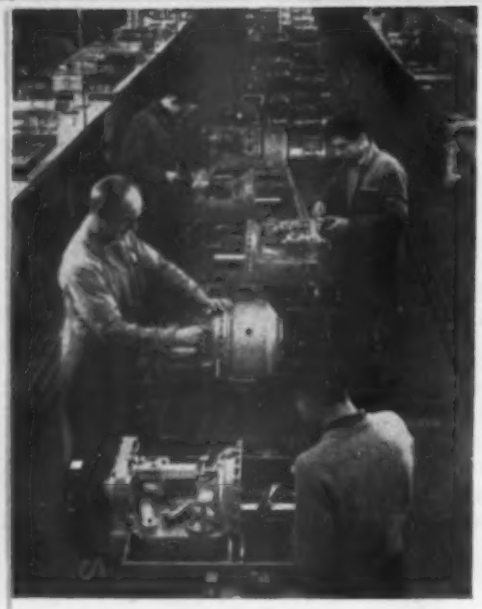
Palouste air-compressor unit ready for installation in a Mk 2A trolley for the Royal Navy. A photograph of a trolley appears overleaf.

For propulsion of fixed-wing aeroplanes, Blackburn can offer the free-turbine Turmo and the single-shaft Artouste. The latter has already been built in quantity by Turboméca for the Sud-Aviation Alouette helicopter and it has been rumoured that Air Service Training, Ltd., may build a British version of the Alouette using a Blackburn-built engine. It is worth noting in this regard that the Blackburn engine can give up to 475 h.p., and should therefore be able to put a constant 400 h.p. into the Alouette rotor head under all operational conditions—a valuable asset.

One of the company's most important sources of aeronautical business at the moment concerns the design and manufacture of what are variously described as A.P.U.s (auxiliary power unit) or A.A.P.P.s (airborne auxiliary powerplant). One of the first A.A.P.P.s to be evolved was an Artouste 510 coupled to a variety of airframe accessory units within a cylindrical container provided with air cooling ports at either end. From this basic unit have been evolved a variety of powerplants, some of which have an air-bleed manifold and can thus deliver shaft-power or compressed air separately or concurrently.

Large and high-flying aircraft of the Royal Air Force—the type or types may not be specified—will be equipped with these versatile Artouste A.A.P.P.s as standard equipment. Each unit will be coupled to a large alternator to provide major electrical power at all altitudes, and in addition an air bleed pipe will feed compressed air to low-pressure air-turbine starters on the main aircraft powerplants for in-flight starting purposes. Details of the operational performance of these A.A.P.P.s may not be published but they are intended for operation up to very high altitudes. Published sea-level figures for the Artouste 510 A.A.P.P. include the following choice of maximum-continuous output: zero shaft-power plus 2.5 lb/sec air at 3.72 pressure ratio (consumption 315 lb/hr); 190 b.h.p. plus 1.4 lb/sec air at 4.00 pressure ratio (consumption 340 lb/hr). Exclusive of the alternator and ducting, the unit weighs approximately 338 lb. An order has also been signed with Canadair, Ltd., for the supply of a somewhat different type of A.A.P.P. for the forthcoming CL-44 transport. This Britannia-derived long-range aircraft will be powered by four Rolls-Royce Tyne engines, and auxiliary power supplies both in the air and on the ground will be provided by the inbuilt Blackburn unit.

An even more extensive market can be seen for ground auxiliary power units. Non-aeronautical applications include marine, industrial and Service fields, one of the largest units being a



(Right) A Mk 2A air-starter trolley is inspected by Mr. K. Stephenson, assistant works manager (engines), and Mr. J. Hall, manager, experimental department. This trolley is used by Blackburn's aircraft division for starting the de Havilland Gyron Juniors of the NA.39.

(Left) Production Palouste air-compressors intended for installation in Jowett-built Mk 2A trolleys.

BLACKBURN-TURBOMÉCA . . .

Turmo coupled to a D.C. generator to form a set rated at 250 kW. For aircraft-servicing purposes Blackburn have developed a self-contained "package" unit which can supply A.C. or D.C. electric current, low- or high-pressure pneumatic power, hydraulic power or a vacuum. This pack weighs about 1,650 lb and can conveniently be mounted on a vehicle chassis (Blackburn illustrate the Land-Rover).

A typical example of a modern weapon system needing a ground-servicing unit is provided by the Avro CF-105 Arrow supersonic intercepter (*Flight*, October 25, 1957). Although no details of the equipment carried by the Arrow may be published, it can be stated that Blackburn have developed a special servicing unit for providing properly conditioned air to the various airborne electronic systems of the Arrow in order to keep them within their specified limits of ambient conditions over the extreme range of temperatures encountered within the Dominion.

Looking ahead, Blackburn are keenly aware of the fact that the large and advanced jet transports forming the next generation of airline equipment will require ground-servicing units of greater capacity than any previously used by airline operators. In the U.S.A. in particular, this potential demand promises to be met by a wide variety of servicing devices intended to provide ground air-conditioning, accessory power, engine-starting services, ground checking supplies for the aircraft systems and provision for moving the aircraft with the main powerplants inoperative. Blackburn are keenly interested in producing comprehensive ground-servicing units for such aircraft as the VC-10 and D.H.121, and feel that their experience in the fields of both engines and aircraft would place them in a strong position in such an enterprise.

At present the company are in full production for the Royal Navy with a wheeled trolley containing a Palouste air-compressor providing a source of low-pressure air for starting the gas turbines of combat aircraft. An essentially similar unit is also being produced in the form of a streamlined pod which can be air-lifted to enable the same aircraft to fly ashore and still remain self-sufficient.

A photograph on page 405 depicts the Palouste power unit itself. The bare engine, which is generally identical with that fitted to the Fairey Ultra-Light helicopter, is approximately 33.5in long, 21.4in in maximum diameter and some 204 lb in weight. Like other units in the Blackburn range, it can be started by any of a variety of means, including hand-cranking (*Flight* found hand-starting much easier than on another type of gas turbine of much lower power), and the unit is cleared to burn petrol, ship's diesel fuel and all grades of kerosine used in gas turbines.

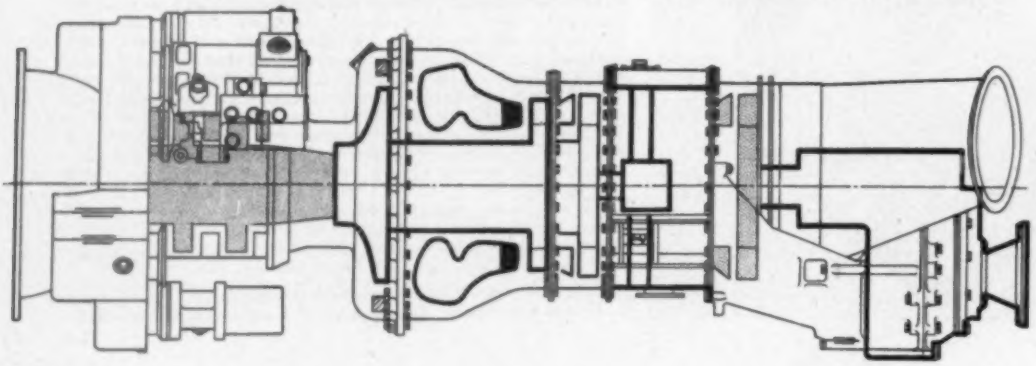
The complete power unit is flexibly mounted on a three-wheeled chassis produced by Jowett Cars, Ltd., a Blackburn subsidiary. The production trolley, which is designated Mk 2A, feeds its air through a continuous hose permanently coupled to the air-compressor and stowed in a compartment on top of the trolley. Air is taken in through a silenced intake above the tow-bar and the efflux issues from large upturned louvres at the opposite end. The complete trolley is approximately 119in long, 49in wide and 37.5in high; the weight is roughly 1,800 lb. It is entirely self-contained. Hand-cranking can bring the engine up to idling speed in a few seconds, after which an automatic cycle takes the unit up to a maximum r.p.m. of some 34,000, opens the valve to the delivery hose, supplies air for the required period and then shuts the unit down. Delivery is 2.71 lb/sec at a pressure ratio of 3.88, i.e., a gauge pressure of some 45 lb/sq in. Production units are being cleared to accomplish 2,000 complete starting cycles without overhaul (or 500 hr general running-time).

A photograph of the airborne starter pod was published in our issue of September 13 last, page 441. This unit weighs only about 970 lb complete with its retractable tricycle undercarriage, and it can be fitted to standard external stores pylons.

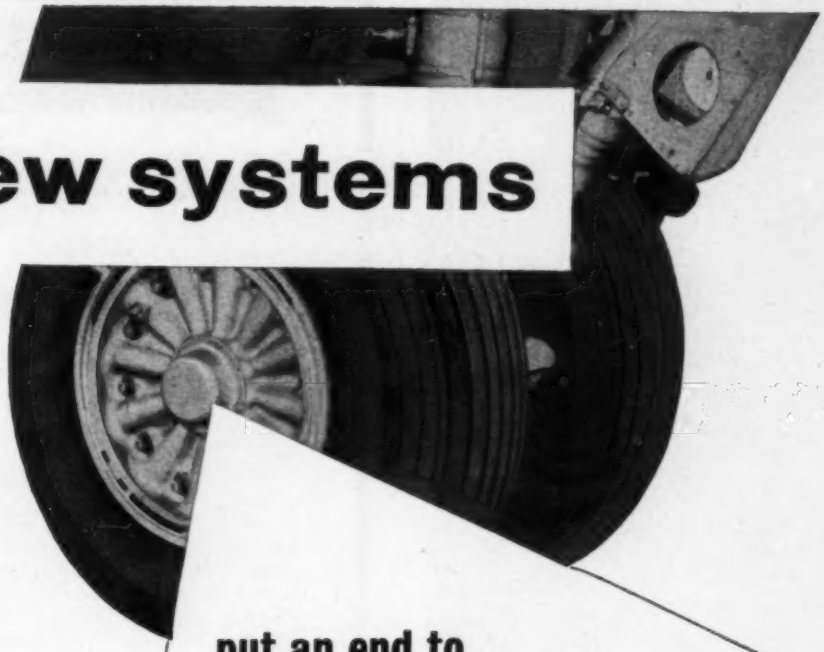
Developments in the U.S.A. have been directed towards making provision for air supplies at greater pressures, and Blackburn have evolved a high-pressure Palouste giving a delivery at 75 lb/sq in. It consists essentially of a basic Palouste to which has been added a mechanically driven centrifugal supercharger (actually that designed for the Blackburn Grenadier piston engine) forming a second stage in series with the feed from the original air-bleed manifold. The added impeller increases the overall length to some 45.5in and the weight to about 250 lb; for an almost unchanged fuel consumption, of some 320 lb/hr, a delivery of 2.3 lb/sec can be sustained at a pressure ratio of 5.4. Blackburn state that a further version can be made available with a pressure ratio of 8.0.

This compound unit leads naturally to consideration of Blackburn's latest engine which forms an interesting parallel to the new range of units developed by Turboméca and described in our world aero-engine review issue of July 26 last. Designated A.129, this new engine continues the standardization inherent in the Blackburn family by employing a virtually unchanged central portion. On the front, however, has been added a two-stage transonic axial compressor (a unit which happened to have been developed for other purposes and which fitted Blackburn's requirements admirably) and the increased shaft-power is provided for by the addition of an extra turbine stage. These changes are shown in schematic form in the diagram below.

Blackburn expect to run the prototype A.129 later this year and the company are prepared to release some basic figures for estimated performance. Operating at a pressure ratio of 6.35, the new engine will have a maximum rating of 950 s.h.p. with the corresponding specific consumption calculated at the competitive value of 0.66; at 850 h.p. the consumption curve rises to the level of about 0.77. With a reduction gearbox, as shown in the diagram, the dry weight is expected to be about 390 lb. Blackburn are producing the new engine as a private venture, and it is expected that it will form the progenitor of a complete new family of engines in the 1,000 h.p. class.



Schematic longitudinal section of the new Blackburn A.129 engine. Shading shows the approximate location of the added transonic axial compressor stages and extra turbine stage. A rear-drive gearbox is indicated.



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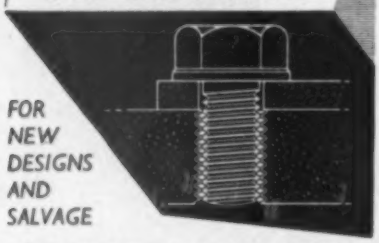

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(c) from four return flights each 28 days to 52 return flights per annum on their Coach Class Service between London and Nairobi.

THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7696

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APPLICATIONS, giving full particulars of education and experience and quoting the names of three referees, are required by 1st May, 1958, and should be addressed to:

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From left to right, top row, these comprise

1 *Blade root bearing for variable-pitch propeller.*
2 *Bearing for an airborne instrument mounting.*
3 *Helicopter rotor torsion hinge bearing.*
4 *Bearing for spider mechanism controlling cyclic pitch of helicopter main blades.*

Bottom row, left to right:

5 *Bearing for variable-pitch propeller blade root, also for helicopter rotor torsion hinge.*
6 *Helicopter tail rotor blade root bearing.*
7 *Light section bearing used for many applications including helicopter blade hinges.*

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